



# Surgery, Gynecology and Obstetrics

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# SURGERY, GYNECOLOGY AND OBSTETRICS

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NUMBER 1

## THE USE OF FREE GRAFTS OF WHOLE THICKNESS SKIN FOR THE RELIEF OF CONTRACTURES<sup>1</sup>

By JOHN STAGE DAVIS, M.D. F.A.C.S. BALTIMORE

THE contractures to be considered in this paper are those following burns injuries and infections in which the skin and often the subcutaneous tissue have been completely destroyed<sup>2</sup>

Contractures have always been surgical hug bears and many methods have been suggested and tried for their relief. Multiple incisions through the scar tissue followed by the injection and inunction of fibrolysin has been advocated but my belief is that fibrolysin has little if anything to do with the occasional good result.

Plastic operations of various kinds have been tried with more or less success. The use of pedunculated flaps is especially valuable when a pad of fat is required in addition to the whole thickness of the skin but this method should be used only in selected cases as it has its limitations. In some instances pedunculated flaps from adjacent tissue are almost impossible to get especially in finger contractures and also when the contracture is in the midst of scar tissue. It is usually easy to secure sufficient tissue by using flaps from distant parts but the constrained position necessary in order to utilize these flaps is exceedingly irksome to the patient, and many are unwilling to endure the discomfort.

No detailed case histories will be given in this report, but photographs are included which give an idea of the cases I have studied. In addition to those shown, contractures in other situations have also been relieved by whole thickness grafts but photographs were not available for lantern slides.

All the methods of skin grafting have been tried. The small thin grafts of Reverdin and the larger grafts of Ollier Thiersch are not as a rule effective especially on exposed positions such as the palmar surface of the hand both on account of the danger of recontracture under the graft and also because of the instability of the result. Small deep grafts while more resistant, are also unsatisfactory for the relief of contractures. On the other hand the graft of whole thickness skin furnishes a most satisfactory solution of the problem and I thought it might be worth while to bring the subject to your attention.

### TECHNIQUE

*Preparation of the area to receive the graft*  
If possible the part should be thoroughly massaged for some time before operation as in this way the surrounding tissues are made more movable the blood supply is improved and better results are accomplished. All of the scar tissue should be excised if this can be done with safety but in many instances the entire part is covered with scar and in these only the contracture should be entirely excised while the movable scar tissue beyond should be utilized. In contractures of the hand I have found it best at this stage to apply a splint, previously prepared and sterilized. This splint should be padded with thick felt and be so arranged that the fingers





Fig 3 Contracture following burn Duration 4 years 1 and 2 (at left) Before operation. The fingers are extended as much as possible 3 Eleven months after whole thickness grafting 4 Five years after grafting The function of the hand is perfect Note the grafts on the finger thumb and palm

*Preparation of the skin from which the graft is taken* Shave the part selected and wash with green soap and water Rinse with sterile water Sponge with ether followed by alcohol Then rinse with normal salt solution and dry with a sterile towel From this point preserve an absolutely dry technique until the graft is in place

*Cutting and placing the graft* Mark out lightly with a scalpel on the skin an elongated ellipse bearing in mind that the edges of the wound caused by removal of the graft should be approximated with but little tension Remove the skin with the underlying fat down to the fascia or aponeurosis covering the muscle As soon as the scalpel has penetrated the subcutaneous fat the skin immediately shrinks about two thirds of its

original size transversely and a little less in its length and this shrinkage must be planned for

Wrap the graft in dry gauze until the wound from which it is taken is sutured and dressed Then trim off all the fat from the graft with curved scissors Perforate the graft in several places to allow the escape of any blood or secretions which may collect Fit the graft into the defect either in one piece or in several pieces depending on the shape of the wound If one piece can be used it is advisable to secure it without tension by four cardinal sutures preferably of horsehair In some instances a continuous horsehair suture is used to fill in between the cardinal sutures and in others a few interrupted sutures The cardinal sutures should be



Fig 4 Contracture following a crush burn between hot rollers Duration 6 months 1 (at left) Before operation Note the limit of extension 2 and 3 twenty one months after whole thickness skin grafting Note complete extension and flexion The outline of the graft can be seen Note slightly roughened and pigmented skin The patient, who is a printer has been able to work at his trade without hindrance since discharge from the hospital



Fig. 5. Contracture following burn of back of hand. D. ration 4 months. (upper left) Before operation. The extent of flexion during the action of the tissue on back of hand. (below) and (upper right) Ten years later. Result (gr. tissue). Not the size of the graft and the ability to flex the hand. The patient pre-operate and has been able to use his hand since operation.

through the full thickness of the graft but the sutures between should be superficially placed and should be as close to the edges of the graft and surrounding skin as possible. Occasionally no sutures at all are used as the graft adheres closely to the dry wound but where no sutures are used it is advisable to secure the graft by means of rubberized mesh. A slight even pressure should be exerted on the graft to hold it firmly against its base but too much pressure should be avoided as it interferes with the vitality of the graft.

The graft should be handled as little as possible and the necessary handling should be most gentle. All of these points seem trivial but on them depends the success or failure of this type of graft. A Thiersch graft may be handled with much less consideration and be successfully transplanted.

It is often advised in textbooks to excise

the scar tissue in one piece and after excision to place it as a pattern on the skin and cut the graft by it but this is not entirely practical as the majority of scars are irregular in outline, and furthermore the scar itself shrinks after excision and the graft after cutting shrinks so little can be gained by this procedure. I consider it essential that the wound from which the graft is taken should be closed at once and not left open as would necessarily follow if an irregular shaped piece of skin of any considerable size were removed. It is advisable to have the size and shape of the defect in mind when cutting the graft but it will be found that a piece of whole thickness skin after removal of the fat is very pliable and can be easily fitted into irregular defects. It is better to have the graft too large than too small and if the defect is irregular the graft may after removal be cut into the desired shape or divided and pieced together. It is of course desirable to fill a defect with a single piece of skin as there are fewer resulting scars but this is often impossible.

**Dressings.** Silver foil dry gauze moist salt gauze which is kept wet or which is allowed to dry out are all excellent dressings. Another dressing which I have found useful is a flexible paraffin mixture used by Carrel for another purpose. Any of these may be used with success but none of them should be used exclusively as the dressing should be chosen with regard to the surroundings of the wound grafted. For instance it is more satisfactory to dress a graft used around the eye with moist salt gauze which is kept wet and often changed as by this means the secretions from the eye are controlled and there is less danger of infection etc.

In children under 10 years of age in addition to the splint in hand and arm contractions I find that it is always wise to put up the part in a plaster cast. If there are no contraindications I do not disturb this cast for at least three weeks and at the end of this period it will be found that either the graft has taken or in case of failure the process of healing has proceeded with the part in good

Formula: Paraffin 120 g. 8 grams, paraffin 40 g. 8 grams, in wax, glycerine, castor oil, cubic centimeter. Mix thoroughly in the wax and apply all body heat.

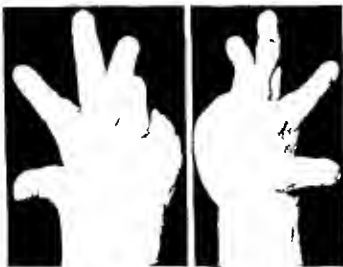


Fig. 6 1



Fig. 6 2



Fig. 6 3 (above)



Fig. 6 4 (below)



Fig. 6 5 and 6 (above)



Fig. 6 7 (below)

Fig. 6 Contracture following burn. Duration several months. 1 to 4 Cast and photographs of hand before operation. Note hyperextension of all fingers. 5 to 7, Taken 22 months after removal of contracture and transplantation of free grafts of whole thickness skin.

position. So in either case no time is lost. Another reason for keeping the cast on so long is that it is almost impossible to keep the part in the original position after once removing the dressing. This method of dressing children also insures immobilization which is most important.

Except in young children where plaster casts are indicated, it is well to keep the grafted area under constant observation without disturbing the position of the part, which should be kept immobile until the blood supply is assured.

**Anæsthetic.** A general anæsthetic is usually necessary in order to remove the contracture, and to prepare the wound for the graft. Advantage is always taken of this anæsthetic to cut the graft, but whole thickness grafts may be easily secured and successfully transplanted after nerve blocking or after outlining the area with a local anæsthetic.

**Early changes.** In whole thickness grafts there may be practically no maceration of the superficial layers while in some instances on the other hand only the corium may remain viable. Now and then an isolated section of a graft will lose its vitality through all its layers and a patch of granulation tissue will appear. This area should be treated as any other granulating wound.

Note large size of graft and that it is placed in the midline of scar tissue. Note the difference in flexion before and after operation. The little finger cannot be perfectly flexed otherwise the patient can make a good fist and has a useful hand.

When the superficial layers are macerated and come away either as a whole or in part and the epithelization of the remaining corium is sluggish it is desirable to scatter over these areas either epithelial scrapings or small superficial grafts including as far as possible only epithelium. These grafts take readily and hasten the epithelization. The final result is excellent.

**Subsequent changes.** The result desired in whole thickness grafting is elasticity, softness, movability, and normal color. Krause says that all of these are obtained in a third of full takes although the same technique is used in all. In some instances a brown or regular pigmentation may appear but this is no more frequent than in areas grafted with thin grafts so need not be particularly considered in cases of contracture where function is more important than appearance. The graft may be cyanotic for some time due to enlarged blood vessels later the surface of a graft may become irregularly shriveled. These changes in no way impair the efficacy of the graft but must be borne in mind from the cosmetic standpoint and the possibility of these complications explained to the patient.

**Histological changes.** The histological changes in the healing process of a whole thickness graft are in general similar to



ing the use of zoo grafts from various animals. My own experience is that these grafts take readily and receive their blood supply as promptly as ordinary grafts. They also have the power of stimulating epithelial growth from the edges when placed on granulating wounds as do other grafts. However in every case which has been under my observation these grafts after doing well and often when the wound is entirely healed will suddenly with no apparent cause begin to melt away and will soon disappear.

*Transplantation of hair bearing skin.* In those cases of contracture in which the eyebrow has been destroyed carefully shaped whole thickness grafts of hairy skin from the pubis with a thin layer of subcutaneous tissue may be successfully transplanted and will relieve the contracture and at the same time form an eyebrow. In transplantation of skin from the pubis the direction of the hair growth should be kept in mind. Hair also grows on grafts taken from the thigh or from any other hairy region. For this reason it is important to choose carefully the region from which the graft is taken.

#### REMARKS

In spite of various best methods of healing wounds and even in the hands of careful surgeons contractures do sometimes occur and will always continue to occur.

Contractures are more likely to follow in those cases which heal by granulation because of the greater amount of connective tissue formed in the slow healing process. They are much less likely to occur in cases where the healing is properly assisted by skin grafting or plastic operations.

Contractures are caused by the formation and subsequent shrinkage of scar tissue which replaces the skin and subcutaneous tissue.

Contractures following burns have been most frequent in my series of cases and then following infection and injury in the order named. I have also had a few cases of congenital contractures of the fingers. The majority of contractures have been on the flexor side. In some cases of long standing there has been subluxation of joints which complicates the treatment.

In cases where the destruction has been deep it may be necessary to lengthen the tendons in order to obtain extension and in one or two cases showing subluxation osteotomy has also been necessary.

When contracture of an eyelid is dealt with it is seldom possible to remove all the scar but as in other situations all tension can be relieved. It is advisable to markedly overcorrect in relieving these deformities as the subsequent shrinkage of the scar and wrinkling and folding of the skin in this situation has to be taken into consideration.

The skin may be taken from almost any situation where there is sufficient laxity of tissue to admit the suturing of the edges of the wound from which the graft is taken.

Grafts may be cut the whole length of the thigh and from as wide an area as can be sutured. By using a boomerang shaped incision a very long and wide area of skin may be secured from the abdominal and chest walls.

Often we find after removing a whole thickness graft that large veins which have not been cut are exposed. It is better to excise these veins for if this is not done there is quite often after closure a thrombosis of the vein without infection but with subsequent pain and discomfort.

A graft of whole thickness may be placed successfully in the midst of scar tissue and accomplish its purpose. The result in these cases being that the graft is more stable than the tissue which surrounds it and it also follows that the scar becomes more resistant as the tension is relieved.

Gentle massage of the grafted area should be started several weeks after operation and the manipulation be gradually increased until the graft moves freely with the surrounding skin.

Whole thickness grafts are used comparatively infrequently for the relief of contractures and many surgeons have never used them preferring to take a chance with the thin grafts.

The operative procedure in securing thick grafts is undoubtedly much greater than in securing thin grafts and occasionally the after-care is difficult and tedious but on



the other hand the healing following a successful whole thickness graft is as stable and firm and pliable as the original skin. I believe that the ultimate result will more than justify the time taken as well as the discomfort experienced by the patient.

## CONCLUSION

Contractures causing complete or partial loss of function and accompanied by hideous and crippling deformities may be relieved by the use of free graft of whole thickness skin and the part restored to its former usefulness.

## PULMONARY FAT EMBOLISM—A FREQUENT CAUSE OF POSTOPERATIVE SURGICAL SHOCK

By WAYNE W. BISSILL, M.D., RICHMOND, VA.

From the Medical Journal.

IT is impossible to review the volumes written concerning the etiology of surgical shock without adding another volume to references already well known to surgeons and practitioners generally. A few references to the literature on fat embolism however are quite essential.

Warthin has recorded the effects on the heart and circulation of injections of oil into the heart directly into the jugular vein and into a heart compensating for an artificially produced valvular lesion. The injection of oil directly into the right auricle of a dog causes a marked fall in carotid pressure and a marked rise in auricular and jugular pressure. Warthin also states that repeated injections cause large systolic pulsations in the right auricle, steady fall of arterial blood pressure and gradual rise of pressure in the jugular vein and right auricle. He does not refer to the similarity between these experimental observations and the clinical observations on the circulatory phenomena of surgical shock.

The fall in arterial pressure and the rise in venous pressure is precisely what we know to be the case in instances of so-called surgical shock, the patient literally bleed to death into his own veins.

Fischer has investigated the capillary circulation of the lungs with special reference to fat embolism. He notes that more than 60 per cent of oil injected intravenously into a rabbit soon lodges in the lungs. He also

calls attention to experiment by Reuter who under his direction injected oil into the arch of the aorta. This fat also was found in the lung. While the experimental technique was admittedly crude in a quantitative way Reuter demonstrated that 62 to 68 per cent of oil injected intravenously could be recovered from the lung and 45 to 53 per cent of oil injected into the arch of the aorta also came to rest in lung capillaries.

Fischer explains the retention of fat in the lung by the great dilatability of lung capillaries, the absence of its venous pressure about the vessel and the negative alveolar pressure about the capillaries. When oil is injected into the aorta he explains its accumulation in the lungs by the fact that rabbit arterial pressure is 100 to 110 millimeters mercury, pulmonary arterial pressure 9 to 12 millimeter and capillary pressure 33 millimeter. The pressure in the greater (arterial) circulation forces the oil through the capillaries into the venous circuit where pressure in the right ventricle is insufficient to force it through the lung capillaries. He admits his failure to explain fully the rising blood pressure in the right heart in pulmonary fat embolism. By inflating the lung alveoli with oxygen to a pressure of 20 millimeters mercury Fischer is unable to force pulmonary fat emboli into the greater circulation. He concludes that a large part of the lung circulation can be occluded without seriously threatening life and that the importance of

fat embolism in man may be overestimated at all events fat embolism as a cause of death can play a rôle only where the pulmonary infarction is very extensive

There are other factors to be considered. I have observed astounding amounts of fat in the venous blood of persons with broken bones and it is presumable that in hæmia from any cause the venous blood is rich in fat. This observation would be of lesser importance had not Gauss demonstrated that addition of 10 per cent of olive oil to blood increases its viscosity approximately three times or expressed in percentages the addition of 10 per cent of olive oil to normal blood increases its viscosity 200 per cent. It being known that pulmonary fat embolism both in man and experimentally in animals causes a decreased arterial pressure and increased venous pressure even to fatal termination it is reasonable to presume that a venous blood rich in fat would offer additional resistance to passage through capillaries due to its increased viscosity. Certainly it cannot be denied that in the lung capillaries where fat is accumulated as by repeated injections the viscosity of the blood must be greatly increased.

During the past eight months I have observed six instances of fatal postoperative fat embolism in the necropsy service of the Mayo Clinic. Three of these followed breast amputation one ventral herniotomy one, craniotomy for brain tumor and one, laminectomy for spinal cord tumor.

I record the following three of these deaths because postmortem examination revealed no lesions other than fat embolism which could be interpreted as important in the explanation of the mechanism of death.

CASE 1 (167261) A hotel clerk 32 years of age entered the Mayo Clinic on July 26 1916 in

#### PROTOCOL OF EXPERIMENT BY GAUSS

TIME REQUIRED FOR ONE CUBIC CENTIMETER FLUID TO ASPIRATE THROUGH THE CAPILLARY UNDER CONSTANT PRESSURE OF 70 MILLIMETER MERCURY NO CORRECTION TEMPERATURE OF 45°C.

	Alcock Plus Olive
	Seconds or Seconds
Salt solution	31 00
Aerated fluid	45 30
Human blood serum	57 00
Human blood slightly diluted with distilled water	60 40

the service of Dr H S Plummer. He complained that ever since boyhood he had suffered the inconvenience of a large umbilical hernia. In 1913 he sought relief in an operation but after two months a hernia occurred in the operation scar. He stated that the hernia was growing larger and gradually becoming more painful and tender.

Physical examination revealed a well muscled but very obese man weighing 222 pounds with a large postoperative ventral hernia. Aside from the hernia he presented no noteworthy clinical abnormalities. On three successive days the twenty-four hour output of urine was normal and the specimens while containing a trace of albumin contained no casts or cells. Fifteen minutes after subcutaneous injection of phenolsulphonephthalein the dye appeared in the urine and in two hours the kidneys returned 110 cubic centimeters of urine there being 47 per cent of phthalein in the sample. The average systolic blood pressure for three days was 133 millimeters mercury and the diastolic 86 millimeters. The blood contained 7,400 leucocytes and 80 per cent hemoglobin. The temperature was always normal.

On August 5 1916 the operation was performed by Drs. Judd and Masson. A long transverse incision was made across the abdomen the hernial sac was freed from its surrounding adhesions to the thick layer of subcutaneous fat and a mass of the great omentum approximately 15 centimeters in diameter was removed. On account of a wide diastasis of the rectus muscles, the closure of the sac was made very difficult and during this part of the operation the patient became quite cyanotic, sufficiently so to cause the surgeons considerable alarm. The closure was completed, however and the patient returned to his bed. He improved during the next twelve hours after proctoclysis and hypodermoclysis. The operation was done toward evening. At its close the pulse was of good quality and the rate was 118 per minute. During the course of the next day the cyanosis persisted and was accompanied by considerable dyspnea. This cyanosis and dyspnea partially subsided by the end of the first twenty-four hours and the patient seemed to be on the way to recovery. During the course of the second day however, the temperature rose gradually to 100.5 F and late in the evening the patient developed a mild delirium. The delirium grew more intense, and by the morning of the second day was associated with tremor and wild hallucinations of sight and hearing. The temperature gradually rose to 105 F and with it the pulse rate increased to 140 per minute. Death occurred within forty-eight hours of the operation. During the second day the respiratory rate rose rapidly, breathing was attended with great effort and there were signs of consolidation of the lobes of the lungs posteriorly (Chart 1).

The patient had offered the history that he had been employed as a bartender and up to three months previous to his appearance for treatment





Fig. 1



Fig. 2



Fig. 3

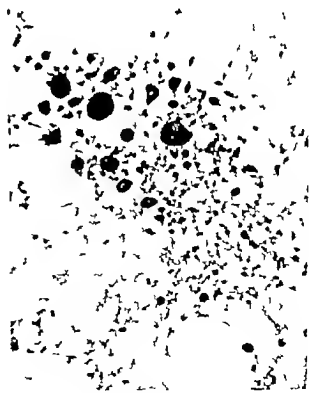


Fig. 4

Plate This illustrates the microscopic distribution of fat in the lungs in the instance of death following umbilical herniotomy. In Fig. fat is seen within the alveoli as well as in the lung parenchyma. The extensive engorgement of the lung in a measure explains the clinical diagnosis of lobar pneumonia. Uncounterstained sudan III preparations  $\times 50$ .

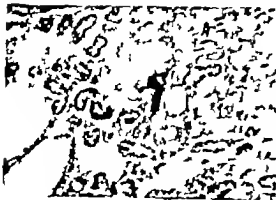


Fig. 1

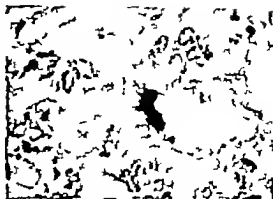


Fig. 2



Fig. 3

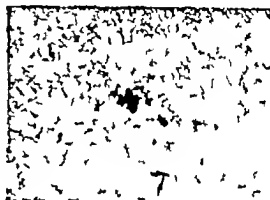


Fig. 4



Fig. 5



Fig. 6

Plate 2. Dissemination of foci throughout the body following pulmonary infection illustrated in Plate 1. Figs. 1 and 2 are of kidney; 3 and 4 are of brain; 5 of adrenal gland; and 6 skin. In considering 3 and 4 it is to be remembered that the clinical cause of death included delirium tremens. Sodium chloride preparations No.

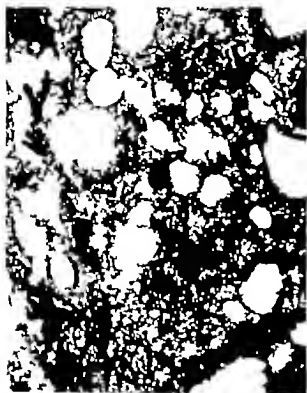


Fig 1



Fig 2

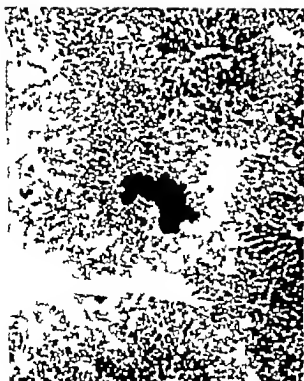


Fig 3



Fig 4

Plate 3 Figs 1 and 2 illustrate extensive pulmonary fat embolism following enucleation of both breasts and cholecystectomy in the second case report. Fat infarction is also observed in the liver and adrenal gland. Sudan III preparations X50



FIG. 1



FIG. 2



FIG. 3



FIG. 4

FIG. 1. The death follicle. Histological preparation of the left breast. It will be supposed to be due to surgical shock. The dissemination of the lung is shown. The histological preparation of part of the lung is illustrated in FIG. 3. Sudan III preparation in X5.

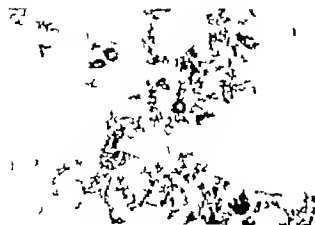


Fig 1

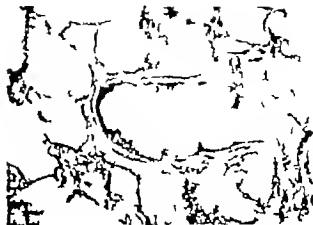


Fig 2



Fig 3



Fig 4



Fig 5

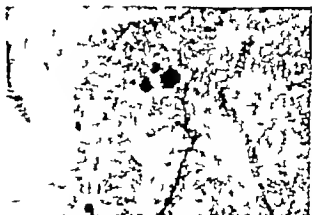


Fig 6

Plate 5. Additional evidence of extensive pulmonary fat embolism illustrated in Figs. 1 to 4. Fig. 5 is a fat infarct in a coil of small bowel. Fat in the large veins of the spleen is illustrated in Fig. 6. All these illustrations are of sudan III preparations of tissues removed at necropsy following Halsted breast amputation for cancer (Case 3).





Fig 1



Fig 2



Fig 4



Fig 6



Fig 8



Fig 3

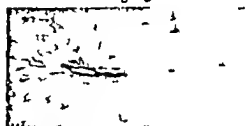


Fig 5

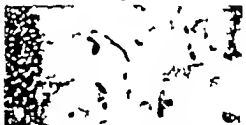


Fig 7



Fig 9

(See page 7 for legend)

ateral disseminated bronchopneumonia marked catarrhal tracheobronchitis slight hyperplasia of the tracheobronchial lymph nodes and of the spleen marked edema of the brain marked postmortem lividity of the entire dependent portion of the body and of the root of the neck and lobes of the ears coalescing petechial hemorrhages in the mucous lining of the greater antrum of the stomach, the duodenum, the cecum and rectum marked cloudy swelling of the kidneys and myocardium marked stony changes in the liver and myocardium slight varicosity of the superficial veins of the legs.

In the microscopic preparations stained with andan II fat emboli are found in the lungs brain, kidneys, liver heart muscle spleen adrenals and skin. Photographs of some of these microscopic preparations accompany this article.

The purpose of this detailed description of necropsy observations and technique is not only to impress the fact that fat embolism is in some instances a fatal complication in laparotomy, but also to outline a technique for the examination of dead bodies which will demonstrate pulmonary fat embolism if it exists. I realize I am presuming that men who examine dead bodies do not know how to demonstrate fat embolism at the necropsy table. This of course is not fair to many pathologists yet the fact remains that fat

embolism is rarely suspected clinically or searched for anatomically unless perhaps in instances of persons dying with broken bones

CASE 2 (170641) A married woman 41 years of age, entered the Mayo Clinic on August 26 1916 in the service of Dr W A Plummer. There were no details in her family personal or menstrual history bearing on her complaint of right upper abdominal cramp-like pain. She stated that since the birth of her seven-year-old child she had suffered occasional attacks of this abdominal pain which necessitated the use of morphine. The spasms of pain were of sudden onset, usually lasting one-half to two hours and never followed by jaundice. In all she had suffered five attacks, the last one occurring two weeks previous to this examination. The pains were never associated with eating. They always radiated to the right shoulder blade. She could not recall that she had had fever with these pains. In addition she called attention to a nodule in the right breast which had been growing since spring.

On physical examination she was found to be a rather stout little woman weighing 165 pounds. Her general health was apparently excellent. A palpable nodular and cystic condition was present in both breasts and there was distinct tenderness over the gall bladder area. There were no aortic enlargements. Examination of the urine revealed nothing abnormal. The blood contained 85 per cent hemoglobin and the systolic blood pressure was 130 millimeters mercury diastolic 78 millimeters. Roentgenographic examination of the kidneys ureters and bladder did not reveal abnormalities. A clinical diagnosis of bilateral fibrocystic mastitis and cholelithiasis was made.

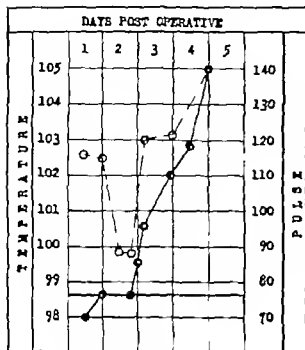
On August 30th four days after admission Dr C H Mayo enucleated both breasts by the conservative Warren operation, preserving the skin and nipples. Under the same ether anesthesia he removed a thick walled gall bladder filled with stones. The entire operation consumed but eighty minutes. Recovery from the anesthetic was normal. Within twenty four hours the pulse rate rose to 120 per minute and the temperature rose from 97° F to 101° some dyspnea and slight cyanosis developed and the patient became stuporous. During the third day the cyanosis increased and delirium followed. Before death the temperature rose to 103.4 and the pulse rate to 136 per minute. The clinical cause of death was given as surgical shock (Chart 2).

Clinically this death resembled both surgical shock and fat embolism. The rapid, running, easily obliterated pulse resembled shock. The dyspnea, cyanosis, delirium, and fever resembled fat embolism. Dyspnea, cyanosis, and delirium, however are noted also in surgical shock.

The necropsy was conducted four and one half hours postmortem in the manner outlined in the first case.

Plate 6 This graphically presents a typical experiment designed to artificially produce fatal fat embolism. A young dog weighing 7.4 kilos was placed under ether anesthesia. Apparatus was arranged to simultaneously record the carotid arterial pressure and the pressure in the right auricle. Twenty three minutes after anesthesia was started, 7 cubic centimeters of neutral olive oil was injected into the right femoral vein. One and two minutes later additional fractions of 5 cubic centimeters each were injected. In Fig 1 the upper light line is the record of venous pressure the heavy line arterial pressure, the lower line, time in seconds and the next lines above signal and base lines respectively. The intravenous injection of 7 cubic centimeters of oil causes a slight but immediate fall in arterial pressure with simultaneous rise in venous. The injection of an additional 5 cubic centimeters accentuates these alterations, while increasing the total oil injected to 17 cubic centimeters causes immediate abrupt rise in venous pressure and fall in arterial. After attempted recovery following the third rise and fall of venous and arterial pressure respectively rapid exodus occurs. The cannulae were removed from the carotid artery and right auricle immediately on conclusion of the experiment to make certain the blood pressures recorded were not caused by clotting. Figs 2 to 9 inclusive illustrate the dissemination of fat throughout the body—sudan III preparations of lung, kidney heart muscle, liver, medulla, adrenal gland, pancreas and right-auricle-clot in the order named. (Nyo)

In any interpretation of this experiment it is to be remembered the animal received approximately two fatal doses of oil.



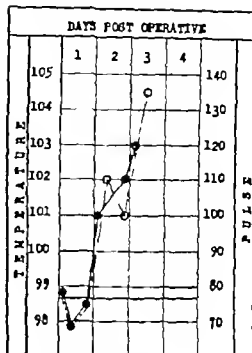
—●—●— = Temperature

-○-○- = Pulse

Chart 1: Temperature and pulse curves after operation.

*Anatomic diagnosis* Recently made urgently repaired and drained wounds inferolateral to each breast and in the right rectus muscle. Absence of both breasts and the gall bladder. Moderate to obesity. Moderate bilateral disseminated fat embolism. Fat droplets in the blood expressed from fresh cuts of lung lobes. Fat droplets in the fluid material in either pleural cavity. In the tracheal and bronchial secretions in the urine and in the blood. In the of the right auricle, disseminated petechial hemorrhages throughout the lining of the small bowel and in the lining of the greater antrum of the stomach. Petechial hemorrhages in the mucous lining of the pelvis of the left kidney and in the visceral pleura of both lungs throughout the peritoneum generally in the trachea and main bronchi and disseminated throughout the visceral pericardium and the capsule of the liver. Marked fatty changes in the liver. Concomitant deformity of the liver and kidneys. Slight bilateral hemohydrothorax. Slight amount of fluid and clotted blood in the dependent portions of the peritoneal cavity. Remarkable increase in body heat. Moderate gas distention of the small bowel. Mucos-hemotracheobronchitis. Marked engorgement of all the large veins of the body and of the chambers of the right side of the heart. Marked general visceroposis. Atrophic striae gravidarum of the skin of the abdomen and thighs.

CASE 3 (17163) The last case report is of a woman 56 years of age entering the Mayo Clinic on



—●—●— = Temperature

-○-○- = Pulse

Chart 2: Temperature and pulse curves after operation.

September 6, 1906 in the service of Dr. Logan. She complained of a tumor mass in the left breast which had been present for three years, accompanied for two years by a swelling in the left axilla. Her disorder was obviously a carcinoma of the breast with axillary glandular metastases. Physical examination revealed no contraindications to operation. She weighed 160 pounds which was her normal weight and there was no evidence of distant metastases of the cancer.

On September 9, 1906 Dr. Beckman removed the left breast and axillary glands by Halsted amputation. The operation consumed 75 minutes. The patient recovered from the ether anesthesia very promptly and her pulse was of good quality. Very soon however the pulse rate increased rapidly and the temperature fell below normal. In spite of vigorous stimulation and application of external heat the temperature continued subnormal and the pulse was very rapid, irregular and difficult to count. There was no evidence of hemorrhage. This condition endured for ten hours before death. The clinical cause of death was given as surgical shock (Chart 3).

At necropsy the following noteworthy gross lesions were observed:

*Anatomic diagnosis* Large recently made surgically incised, repaired, and drained wound of the left breast and axilla, absence of the left breast and the left axillary lymph nodes. Slight surgical trauma

to the left axillary vein moderate bilateral disseminated pulmonary fat embolism moderate bilateral hypostatic hyperemia and edema of the lungs moderate bilateral hydrothorax petechial hemorrhages in the mesentery of the small bowel and in the capsule of the spleen pinhead sized petechial hemorrhages in the skin moderate obesity left apical fibrous adhesive pleuritis moderate general anemia marked engorgement of all the large venous trunks of the body slight chronic diffuse nephritis — slight secondary contraction of the kidneys marked cloudy swelling of the liver and kidneys varicose veins of the legs

In considering the two deaths following breast amputations clinically supposed to be due to surgical shock I would refer the reader to the masterly writings on fat embolism published thirty three years ago by Dr Roswell Park Dr Park writes as follows

CASE 11 During the past winter I was present at an operation for the removal of a cancerous breast from an extremely fleshy woman The operation was made by one well qualified to undertake it, and passed off without anything unusual transpiring except perhaps, that it was somewhat prolonged. The gland was imbedded in adipose tissue and I noted both that venous oozing was free and that the fatty tissue crumbled readily under the sponge and even seemed to melt down The operation was begun about half past ten The lady never became completely conscious and died comatose about five o'clock, with nearly every symptom that I have detailed above<sup>1</sup> I am well aware that in this case the trouble may be ascribed to the anæsthetic and with some reason and yet all things considered I hold that the case can be properly classed as fatal from fat embolism Unfortunately autopsy which might have cleared this all up was denied.

In concluding this article Dr Park said

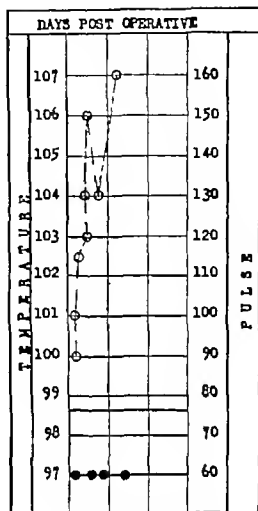
1 Fat embolism in varying degrees of severity is not an uncommon complication of surgical accidents and operations

2 It may be so mild as to be lost sight of in the general condition of shock or perhaps more properly speaking it is one factor of a condition of prolonged shock<sup>2</sup>

3 Our knowledge of the subject will be greatly increased when we appreciate the possibilities of its occurrence and observe our cases more closely, watching for the appearance of fat in the urine, of slight dyspnea, etc

4 When prostration and loss of blood have been great a moderate amount of embolic disturbance of this kind may serve to turn the scales against a patient who would have otherwise recovered.

<sup>1</sup>The symptoms detailed were Early paleor somnolence; gradually increasing respiratory rate; increasing dyspnea; weak, rapid, irregular pulse; subnormal temperature 1 first, but atypically delirium and coma.



—●— = Temperature

—○— = Pulse

Chart 3. Postoperation temperature and pulse curves typical of surgical shock.

5 By a proper understanding of this subject certain deaths may be explained which otherwise seem inexplicable

6 Treatment can only be symptomatic, but may accomplish something

7 Autopsies should be so conducted as to reveal this condition when present<sup>3</sup>

Among more recent and noteworthy physiologic investigations concerning the influence of vasomotor mechanism in producing a condition of surgical shock the article by Dr Mann is most interesting By experimentation on dogs he concludes

The clinical signs of shock which appear after section of the abdomen and exposure of the viscera are due to a loss of circulatory fluid. This loss of fluid is not dependent upon any primary impair

<sup>3</sup>Italics are mine.

ment of the medullary vasomotor center and takes place at a point beyond the control of the vasomotor mechanism. The causes for this loss of fluid are apparently the same as those which determine the accumulation of fluid in any other irritated area and produce the signs of inflammation. The nervous system probably plays no greater part in the former case than in the latter. The condition is made grave when the viscera are exposed because of the great vascularity of the tissues involved.

Mann's conclusion that the conditions bringing about shock are beyond control of the vasomotor mechanism is indeed gratifying.

Published with this article there are addenda by Bloodgood which concern his critical review of a paper by Mann published a year previously. Bloodgood's criticism is of Mann's statement that it is impossible to reduce the anesthetized animal to a state of shock by any degree of sensory stimulation providing all hemorrhage is prevented and the abdomen not opened. Bloodgood's criticism is as follows:

In my experience with operative surgery under general anesthesia in which the condition of the patient has been most carefully recorded and the blood-pressure changes estimated during the entire operation, I have observed extreme degrees of shock in operations other than on the abdomen even though there had been no hemorrhage for example, during operation for old, badly united fractures of the shaft of the femur. In these cases the only factors which could have produced shock were the painful stripping of the periosteum and the extreme extension of the limb.

He later adds:

Among my records there is an anesthetic chart which portrays an extreme degree of shock apparently due to an overdose of ether only then a second chart recorded during a shoulder-girdle amputation in which there was practically no hemorrhage. The only etiological factors for the shock were ether anesthesia and trauma.

The reason for citing Park's case is to express the opinion of a leading surgeon of a former time and to compare it with that of a leader in present-day surgery. Had cases been traded about, Park would have had every reason to consider Bloodgood's cases as instances of fat embolism and on the other hand Park's case might well have been an instance of surgical shock in Bloodgood's judgment. The real difference in judgment

however is a fundamental one. The diagnosis of fat embolism clinically is based on observations of phenomena produced by distinct unmistakable lesions grossly demonstrable at necropsy while the clinical diagnosis of shock is based on observations of signs and symptoms exactly duplicated in pulmonary fat embolism, but so far as I am aware, not satisfactorily explained in the examination of dead bodies unless hemorrhage or pulmonary fat embolism is found.

The instances of surgical shock cited by Dr. Bloodgood can be classified with pulmonary fat embolism and withstand the test of most severe clinical criticism. It is to be remembered that operations on old ununited fractures and amputations generally are exciting causes of fat embolism.

Since this paper has been in progress Porter has published a note concerning fat embolism as a cause of shock. His third conclusion reads: Fat in the blood stream is known not to be injurious *per se* its injurious effects are the product of fat embolism.

This conclusion can be contested at least until we know that the increased viscosity of lipaemic blood is not a factor in the retention of large amounts of fat in lung capillaries and in the venous circuit generally. Porter does not distinguish between pulmonary fat embolism and disseminated fat embolism. He offers no explanation of the mechanism of surgical shock as caused by fat embolism.

The exact mechanism of the death, the mode of entrance of fat into the blood stream, the peculiarities of fat or metabolism, if there are any which render fat more easily liquefied to enter the blood stream, the relative proportion of fat in the circulating arterial and venous blood, the viscosity of circulating lipaemic blood and the influence of ether anesthesia on pulmonary fat embolism are some of the more important problems to be undertaken to clarify our understanding of this manner of death and to point the way to rational treatment.

However extensive and varied our investigations may be, there are certain very simple and trustworthy clinical data which demand consideration. The frequency of post

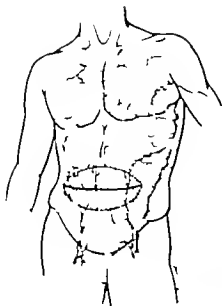


Fig. 1

Fig. 1 Diagrammatic sketch of the larger superficial veins of the trunk anteriorly. The heavy line indicates the incision for umbilical herniotomy. The dotted lines describe an elliptical area of unavoidable surgical trauma in subcutaneous fat rich in large veins.

Fig. 2. Large areas of injury to subcutaneous fatty tissues and veins in operations for conservative enucleation

operative surgical shock in obese persons as compared to its occurrence in the emaciated or only moderately well nourished is one of these heretofore unexplained yet unmistakable clinical observations

From his wide experience Dr W J Mayo so firmly believes perfect hæmostasis to be the positive prophylaxis against surgical shock that he frequently criticizes the now common notions of this clinical complex and insists that with perfect hæmostasis there is no shock.

In this connection another simple observation may be cited. In operations in subcutaneous fat, such as the umbilical herniotomy and the breast amputations here reported it is the common practice for surgeons to ligate the peripheral or bleeding ends of severed veins and leave unligated the central ends which ooze but little blood. With the pressure incident to wound retraction temporary hæmostasis is made on the central ends and the possibility of their opening after closure of the wound is overlooked because



Fig. 2



Fig. 3

of breasts. Because of omission of undercutting, it is noticeable that few veins are opened by an incised right rectus laparotomy wound.

Fig. 3. Extensive injury to subcutaneous fatty tissues and veins is caused by radical Halsted amputation of the breast.

experience has taught the surgeon that only the peripheral end of these severed subcutaneous veins is likely to bleed. In all of these wounds a pool of blood serum and oil globules accumulates after wound closure. It seems reasonable to presume that the gaping mouths of cut veins in such wounds may receive even large quantities of oil material which is conveyed to the lungs through the venous circulation (Figs 1 2 and 3)

#### EXPERIMENTAL

I have repeated the viscosity experiments devised by Gauss and have obtained results entirely similar to his. In addition it is noticeable that if the dispersion of the oil globules is sufficiently great (the emulsion sufficiently fine) the viscosity of the vehicle is not only not increased, but in some instances the emulsion even seems to be less viscid than the vehicle alone. This is true for normal salt solution, ascites fluid human blood serum and citrated blood.

Many animals have been injected intra

venously with neutral olive oil and the effects on circulation recorded. These experiments have been conducted as Warthin conducted them and similar results have been obtained.

It is so obviously true that oil introduced into the venous circulation causes a marked rise in venous pressure and an associated fall in arterial pressure that our attention should now turn to the mechanism of these alterations. It is to be expected that with fall in arterial pressure and rise in venous pressure there is a marked decrease in perfusion rate of the lung. Experiment designed to measure the perfusion rate in lungs infarcted with fat are now in progress.

#### CONCLUSIONS

1. Deaths clinically supposed to be due to surgical shock are due in so far as this experience goes to pulmonary fat embolism and its attendant blood pressure phenomena.

2. Pulmonary fat embolism causes a lowering of arterial blood pressure and an elevation of venous blood pressure which may be sufficient to cause death.

3. Infusions (intravenous) are contra-indicated because of the increased pressure on the right heart.

4. By simple methods pulmonary fat emboli may easily be demonstrated at necropsy.

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## OBSERVATIONS ON THE RELATION OF ACIDOSIS TO ANÆSTHESIA

By GUY A. CALDWELL, M.D. and MATHIEU CHAVELAND, M.D. N. Y. C.

IN January 1916 with consent and aid of the Surgical Department we undertook the investigation of the question of acidosis in its relation to the various anesthetics in use at the Presbyterian Hospital. It was our purpose to determine the degree of acidosis induced in the various surgical processes what was the difference if any between the various anesthetics in this respect and what symptoms if any might be attributed to acidosis. To that end we have made observations on the blood of about 100 patients together with their acetone and diacetic acid excretion during the period of preparation, operation and recovery.

#### SUMMARY OF THE CURRENT LITERATURE

Extensive work has been done of late in connection with the question of acidosis in

general and this has been clearly summarized by Stillman of the Rockefeller Institute from whom we quote the following abstract:

By acidosis is meant a decreased alkaline reserve of the blood rather than an increased acidity. An accumulation of acids sufficient to create an acid reaction in the blood and tissues is incompatible with life. The alkalinity of the blood is maintained chiefly by the amount of bicarbonate which it contains. This amount may be estimated indirectly in terms of the alveolar carbon dioxide tension of the air in the lungs directly by the power of the blood to combine with carbon dioxide.

If acids accumulate in the blood and tissues sufficient to neutralize a portion of the bicarbonate there present they reduce the alkaline reserve of the blood and tissues below normal. When this occurs, it is accompanied by a diminution in the power of the blood plasma to combine with carbon dioxide, and consequently causes a parallel diminution in the alveolar carbon dioxide. This condition is known as acidosis, although an acid reaction of the blood never

occurs unless in *extremis*. Acidosis therefore, may be termed as a lessened bicarbonate reserve in the blood and tissues. It may be caused either by an overproduction of acid bodies in metabolism or by a lessened excretion of these substances.

The need of a method to determine the amount of acid bodies in the medium where the accumulation takes place is obvious. That medium is the blood. Tests of the urine are valuable only for the excretory phase of acidosis. They may be misleading in that they give no index of the accumulation of these substances in the blood due to overproduction or faulty elimination.

*Methods of determining acidosis.* Until recently, urinary tests alone have been used as indices of acidosis. These tests have included qualitative determinations for acetone and diacetic acid, quantitative determinations of the acetone bodies of ammonia, and of total acidity. So long as excretion keeps pace with acid formation, tests of this nature are satisfactory, but when the excretion of acid substances is imperfect, as may occur in diabetes, the elimination cannot keep pace with the production. Therefore urinary tests may not reveal the degree of acidosis present.

#### DETERMINING THE ALKALINITY OF BLOOD

There are in use at present a number of direct and indirect methods for the determination of the alkalinity of the blood. Various forms of apparatus have been devised for the determination of the carbon dioxide tension of the alveolar air of the lungs, a favored simple one being the Frederika apparatus. Others have used methods in which the titratable alkalinity of the blood is determined by color indicators and by hydrogen ionization, but they are all open to many objections and the errors due to personal factors are large. Former methods for the determination of the carbon dioxide tension of the blood were tedious and cumbersome, but the apparatus which has recently been devised by Van Slyke of the Rockefeller Institute has been found to be a very exact, simple and direct way by the laboratory and metabolism workers at the Presbyterian Hospital and accordingly has been chosen by us for making these observations. In dealing with anesthetics, the question of the methods to be used was limited to observations on the blood and urine, because it is not feasible to obtain alveolar air without the co-operation of the patient.

*Technique.* The technique used here has been essentially that of Van Slyke as recently

reported in the proceedings of the Society of Experimental Medicine and Biology.

Ten to 15 cubic centimeters of blood were taken by venous puncture at the times indicated. The blood was received in a centrifuge tube containing sufficient calcium oxalate to prevent clotting and the tube corked and the blood centrifugated. Three to 4 cubic centimeters of the plasma were pipetted into a 250 cubic centimeter separatory funnel and saturated to capacity with alveolar carbon dioxide. One cubic centimeter of this plasma was then pipetted into the container of the Van Slyke apparatus and the volumetric readings of the carbon dioxide obtained from the plasma were made. A second reading was made on each specimen of blood for control. These readings were corrected for temperature and barometric pressure and translated into terms of alveolar carbon dioxide tension according to the tables prepared by Van Slyke in his earlier work.<sup>1</sup>

*Symptoms of acidosis in relation to carbon dioxide tension.* Observations on normal individuals under normal conditions show that by far most of them have a carbon dioxide tension above 40 millimeters; a few, however, with no unusual symptoms may have a carbon dioxide tension between 40 and 35 millimeters. Hence the lower limit of normal is usually placed at 35 millimeters.

The respiratory center is stimulated by a decreased alkaline reserve or increased H ion concentration of the blood. The point at which the response to this stimulus becomes perceptible is variable in various individuals. Many patients, however, have been observed with readings between 35 and 30 millimeters without perceptible symptoms that might be regarded as caused by decreased alkaline reserve, probably because such patients have a larger reserve lung capacity which enables them to compensate with less apparent effort.

From observations on diabetic and nephritic patients in the medical wards of the Presbyterian Hospital, as well as from pre-

In this paper the figures represent the carbon dioxide tension in millimeters of mercury of the alveolar air and are employed because acidosis is best understood in those terms by most clinicians. To convert them into figures representing the percentage of bicarbonate carbon dioxide in the blood plasma, the terminology of Van Slyke is being employed. In Van Slyke's (in press) our figures representing the carbon dioxide tension in millimeters of mercury should be multiplied by the constant .45.



vious observations on acidosis by observers using other methods the earliest clinical signs of acidosis are vague irritability mental torpor or lessened physical alertness. Such symptoms have been observed with readings between 35 and 30 millimeters. The most characteristic early symptom is hyperpnœa, or dyspnœa of the Kussmaul type which has been observed with readings between 30 millimeters and 25 millimeters. Drowsiness headache, vomiting acetone odor to the breath the more marked symptoms of the onset of coma, have been observed with readings from 25 to 20 millimeters. Cases with readings below 20 millimeters are usually in coma, but not necessarily so as is shown by one case cited here and another seen in the medical wards.

It has been observed also that a patient may have a real acidosis as indicated by readings of from 30 to 25 millimeters, without very apparent hyperpnœa provided he be maintaining that level from day to day or gradually raising it but if the alkaline reserve be diminishing from day to day the hyperpnœa is nearly always apparent.

There are a great many factors concerned in the production of the milder degrees of acidosis and many of these have been determined by previous workers using various methods (1). It is well known that fasting alone results in a diminution in the alkaline reserve and causes the appearance of acetone bodies in the urine. But it has been found that while there is a diminution during the first few days of fasting it is gradually compensated for in the normal individual during the next few days of continued fasting and will persist at practically normal for several more days of fasting.

Diarrhœa and prolonged fasting (2) have been found to produce more or less diminution of the alkaline reserve particularly in children where at times symptoms of the more severe grade of acidosis have been observed associated with marked changes in the blood urine and alveolar air. Slight changes have been observed also after intense purgation.

Except for the work of Crile, there have been few if any reports on the acidosis of anesthesia, in which observations other than those on

the urine were used as criteria of the acidosis (4 and 5). In connection with anesthesia (4) Crile has found that both ether and nitrous oxide produce immediate increase in the hydrogen ion concentration of the blood. I.e., increased acidity in the blood during anesthesia and that this acidity is neutralized in an animal in 30 minutes after recovery. He found also that fasting before and after the anesthetic is an important factor in that it checks the acid neutralizing power of the liver. He believes the administration of morphine before operation to be beneficial because less of the anesthetic is required hence the degree of acidosis is lessened (the morphine itself not affecting the acidity of the blood). He discourages its use after operation however because it prolongs the period of neutralization, and in large doses prevents neutralization. Hence he says, it would appear that morphine controls the mechanism governing alkalization or neutralization of the blood. Operative trauma should be minimized because it materially effects the alkalinity and fear worry and anxiety likewise have some influence but this can be checked by using bromides before operation.

In our work it was deemed advisable to obtain a normal reading on patients 12 to 24 hours before operation while they were still on regular diet and before catharsis had been given. In the earlier part of the work normal types were chosen to the exclusion of those complicated with infection new growths, chronic renal or cardiac disease.

In order to determine the immediate effects of the anesthesia and operation readings were made on blood drawn immediately before the anesthetic was begun and this compared with readings on a specimen taken immediately at the end of the operation. In a few cases, specimens were taken at short intervals during the operation readings made, and a curve plotted for the diminishing alkaline reserve.

The period of recovery was studied by taking blood from the same patients 24 hours after operation and in many cases, several days later when the temperature was normal and the patient had been taking soft or regular diet.

TABLE I—A COMPARISON OF CARBON DIOXIDE READING IN THE VARIOUS ANÆSTHETICS

	Average Readings mm. CO <sub>2</sub> in Relation to Preparation and Operation								Recovery of Consciousness Per Cent			Nausea Per Cent			Vomiting Per Cent			Headache Per Cent			
	Reading 4 Hours before Operation. ( )	Reading Immediately before Operation. ( )	Reading Immediately after Operation. ( )	Reading 4 Hours after Operation. ( )	Difference between (1) and ( )	Difference between ( ) and ( )	Difference between ( ) and ( )	Duration of Anæsthetic (Minutes)	Ratio of Blood Alk. Per 100 to Min. Anæsthetic	Delayed	Early	Immediate	None	Moderate	Severe	None	Moderate	Severe	None	Moderate	Severe
Gas and ether Bennett, 43 cases	43	7	40	35	8	4	6	3	6	4	3	3	8	7	8		79		26	14	
Ether open drop, 3 cases	43	7	40	35	8	4	7	3	3	3	3	3	77	8		83	77		69	3	3
Gas and oxygen, 14 cases	43	7	4	37	6	4	3	8	3	8	44	6	8	45	45	64	36		64	36	
Local anæsthetic, 6 cases	41	0	38	34	0	39	7	4	7	3	3	4	8								
Chloroform cases,	4	36	0	34	35	3	3	8		50	5	33	4	5	33	66		34	66	10	83
Treated cases, 7	41	3	44	7	43	7	4	3	3	4	5	7	7	40	3	30	14	57	0	57	4

Rise as contrasted with fall in untreated case. †Fall as contrasted with rise in untreated case.

Tests for acetone and diacetic acid were made on specimens of urine obtained on the morning of operation and again on the first specimen voided after operation. The results of these tests together with their relation to the carbon dioxide tension, are reported in the latter part of this article.

One hundred and twenty three cases have been thus followed and they have been grouped in the following series according to the anæsthetic given, and whether or not any treatment for acidosis was used in connection with them.

Anæsthetic	Number of Cases
1 Gas and ether by the Bennett apparatus	43
2 Gas and oxygen	14
3 Ether open drop method	13
4 Local anæsthesia	7
5 Chloroform	18
6 Treated cases, various anæsthetics	15
7 Ungrouped cases	20

In connection with the laboratory observations careful notes were made regarding each patient as to the condition before, during and after the anæsthetic, the length of the anæsthetic, character of the operation and mode of the recovery as to nausea vomiting headache delayed consciousness postoperative complications and unusual symptoms. The forms of treatment have varied and in all cases have been controlled by readings before and after

the administration to determine the effect on the alkaline reserve of the blood. Sodium bicarbonate was administered in doses of from 20 to 40 grams by mouth during the 12 hours prior to operation, or in the form of 4 per cent solution in normal saline intravenously during and after the anæsthetic, and has been combined with glucose and soda bromide by rectum after operation.

*Features of the average curve* With rare exceptions cases receiving no sodium bicarbonate before their operation showed a lower carbon dioxide tension in the specimen taken immediately before the anæsthesia, as compared with the specimen taken the day before. This undoubtedly is due in part to their fasting state, dinner the evening before and breakfast on the morning of operation having been omitted and in part possibly to the preparatory catharsis. How great a part nervous factors play it is difficult to state.

With but three exceptions all observations showed that the carbon dioxide tension is further diminished during the anæsthetic and operation, varying but slightly in degree with the type of the patient, length and type of anæsthetic used and the character of the operation.

Despite the fact that the patient's fasting was continued and that he usually vomited



Chart Showing average readings taken 24 hours before operation, immediately before operation immediately after operation and 4 hours after operation, in 3 cases of the open series

moderately the alkaline reserve began to increase within an hour after the operation and readings of specimens obtained 24 hours after the operation were practically the same as those taken immediately before the operation. By the second day after the operation readings were practically the same as 24 hours before the operation, and if not were found to be normal or slightly above within a day or two after the patient was given a diet.

From the reading obtained on each patient a graphic chart has been constructed similar to the accompanying ones in which readings have been charted in relation to the time at which they were taken i.e. the normal reading 24 hours before operation is placed in the first column to the right of the scale which reads up and down the reading immediately before the anesthetic in the next column to the right, and any reading taken during the anesthetic, at its proper point the figures at the top of the chart indicating five minute periods for a space of one hour. The wider columns at the right on the same scale, allow for readings on the first two days of the post operative course.

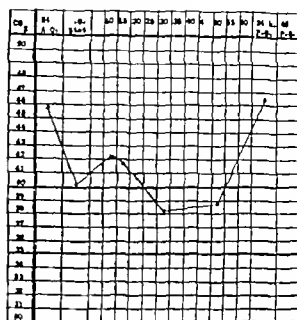


Chart Showing readings taken at various intervals during 5-minute intervals of anesthetic gas and ether Bennett apparatus operation suprapubic cystostomy for removal of renal calculus

In these charts a summary has been made in each series together with the clinical rates and the averages are given in the tables which follow.

The essential facts brought out by these charts 1 2 3 and 4 and Table I are

- 1 That the average normal reading is between 40 and 44 millimeters carbon dioxide
- 2 That there is a diminution in alkalinity of from 3 to 4 in the 3 hours prior to operation, probably due to fasting plus purgation
- 3 That there is further limitation of from 3.3 to 5.3 during anesthesia 1.44 to 1.8 minutes.
- 4 That the diminished alkaline reserve is compensated largely in the first 4 hours after operation, the rise being to 6.5 millimeters carbon dioxide (chloroform being somewhat lower than the other averages)
- 5 That operations under local as well as those under general anesthesia show a diminution in alkaline reserve.
- 6 That there is but negligible difference between the various types of anesthesia as to the degree of diminution but after chloroform there is some delay in the return to normal
- 7 That a larger percentage of gas and oxygen cases have no nausea and vomiting than follows other general anesthetics although that series shows a rate of diminution equal to that of the gas and ether series.

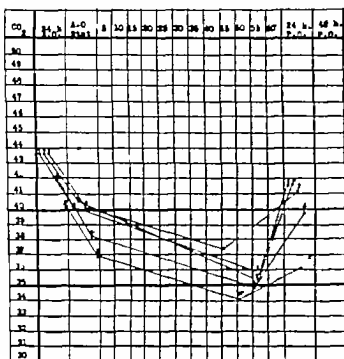


Chart 3. Chart showing averages of readings taken 24 hours before operation, immediately before immediately after and 24 hours after operation in connection with (1) gas and ether (2) ether open (3) gas and oxygen (4) local anesthesia and (5) chloroform.

8 That by the administration of sodium bicarbonate by mouth the normal alkaline reserve may be so increased that the usual diminution in the 24 hours preceding operation may be obviated and instead of a lower reading a higher reading will be obtained immediately before operation. Further more it reduces the rate of diminution during the anesthetic by half but does not necessarily preclude it. In such cases however the postoperative compensation or increase in the alkaline reserve is replaced by a slight diminution i.e. a return to about the normal level of 24 hours before operation prior to the administration of sodium bicarbonate.

9 That the postoperative course as to the recovery nausea vomiting, and headache is not appreciably affected by the treatment which has completely compensated for the diminished alkaline reserve that usually occurs in the 24 hours occupied by the preparation and operation.

10 That the diminution in the alkaline reserve below the average normal does not reach the point at which the earliest clinical symptoms are observed to begin.

Further facts gleaned from the summary in relation to—

1. *Infections and postoperative pneumonias* (7 in fections and 3 pneumonias). There were no constant variations from the usual results obtained.

2. *Peritonitis general*. There were two cases on which no readings were obtained before operation

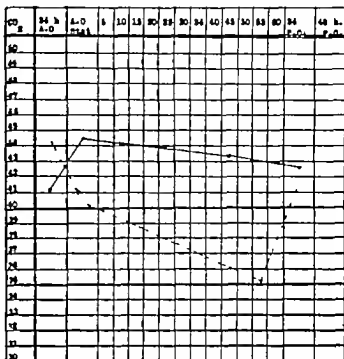


Chart 4. The reversed curve obtained from average readings on 7 cases which had received sodium bicarbonate 20 to 40 grams, in the 24 hours before operation. The average readings in the ether-open series are charted in dotted lines to show the contrast.

but with readings taken immediately after operation. One case died the first day after operation of sepsis. The reading after operation was 38.6 and on the following day shortly before death was 44.8 millimeters.

The second case of peritonitis survived with the usual long convalescence accompanied by the development of a subsequent pelvic abscess. The anesthetic was poorly taken. The reading at the end of the operation was 36.05 millimeters and 24 hours later was 38.6. 48 hours later was 44.1, and varied thereafter between 42 and 43.7 millimeters while the patient was gradually overcoming the infection, and was 42.5 millimeters after the wound had entirely closed and convalescence established. In other words the return to normal was not impeded in these cases by even so extensive an infection as general peritonitis.

3. *Carcinoma*. Readings 24 hours before operation on 3 cases of carcinoma have not varied from normal, being above 40 millimeters and showed no unusual curve in relation to the anesthetic operation and recovery.

4. *Operative trauma*. The comparisons are difficult owing to the variations in the length of the anesthetics. A rough unit of comparison is obtained by dividing the average length of the anesthesia, stated in periods of ten minutes, into the difference between the readings obtained immediately before operation and immediately after operation. With this unit of comparison 12 laparotomies have been

contrasted with 11 extra-abdominal operations (hernias being included in the latter)

The abdominal cases show a rate of diminishing alkalinity of 0.80 millimeters carbon dioxide per 10 minutes, while the extra-abdominal cases show a rate of 0.76 millimeters per 10 minutes.

#### SPECIAL CASES

The series of treated cases includes three diabetics, two of which were moderately severe, showing marked traces of acid bodies in the urine with large quantities of glucose, and a third who was evidently suffering from marked acidosis i. e. was very hyperphoric and drowsy had a sweetish breath and had a large caruncle

**CASE A.** Right direct inguinal hernia and double hydrocele. *Treatment.* Fasted for three days, then the urine became sugar free and remained sugar free on standard strict diet for one day before operation. Operation was done on the fifth day the patient having at the time no glucose in the urine, but faint traces of acetone and diacetic acid. The anesthetic lasted hour and 37 minutes recovery was early and accompanied by severe vomiting and nausea during the 12 hours following the operation, but no other unusual symptoms. The urine on the following day however contained 7.38 grams of glucose with very heavy traces of the acid bodies. Although fasting was continued for 6 days after the operation he continued to excrete diminishing quantities of glucose, the ketonuria became less and less marked, and disappeared when the urine became sugar-free. The blood carbon dioxide on admission was 40.6 millimeters after 3 days fasting was 37 millimeters immediately before operation was 35.8 millimeters at the end of 1½ hour anesthetic was 38.3 millimeters 24 hours later a marked contrast to the usual case which returns to practically normal (except in the chloroform cases) his reading was 27.8 millimeters. Treatment other than fasting was purposely withheld in order to determine, if possible what symptoms he might show with readings at that level. He slept most of the time, but could be easily aroused, and really did not appear more drowsy nor in any way different from the patients who received routine doses of bromides after operation. At the end of 48 hours, however because the reading was 38.07 he was given an infusion of sodium bicarbonate in normal saline. He had a chill following this, and the reading following it was 40.6 millimeters but there was no noticeable change in his clinical appearance during the next few days although his carbon dioxide tension remained at about the normal level. After 8 days of fasting he became sugar-free. His carbohydrates were rapidly increased without the appearance of sugar and he had an uneventful recovery

**CASE B.** Pelvic abscess. 35 grams of glucose in the 24 hour specimen of urine. *Marked ketonuria.* Blood carbon dioxide 33.1 and 32.8 millimeters on consecutive days without visible hyperphoria. Patient was cared for by the metabolism department. Fasting with the administration of 10 to 20 grams of sodium chloride by mouth each day. At the end of 6 days blood carbon dioxide was 42 millimeters. Two days later a posterior colpotomy was done under gas and oxygen. A reading was not obtained immediately before operation, but at the end, was 40.2 millimeters. During the next 24 hours it rose to 37 millimeters (fasting and sodium chloride, 15 grams each day being continued) and at the end of 48 hours was 31 millimeters, and on the seventh day postoperative was 48.3 millimeters.

**CASE C.** Carbuncle of the back of the neck. Emergency operation. Urine showed very heavy reduction for sugar and marked traces of the acid bodies. Patient was markedly septic, hyperphoric and had a sweetish breath. Gas and oxygen was given for 9 minutes for the incision and drainage. Blood was taken immediately before and immediately after the administration of the anesthetic. Patient took the anesthetic very poorly, his color was bad although he breathed very deeply and rapidly and was given a high percentage of oxygen. The specimen of blood taken immediately before the anesthetic read 3 millimeters carbon dioxide that at the end 10.5 millimeters carbon dioxide. Ten hours later the patient was still showing the exaggerated symptoms enumerated but was not in coma. Reading taken immediately before an infusion of 4 per cent sodium bicarbonate in normal saline was 9.4 millimeters 36 hours later the reading was 37.8 millimeters. The symptoms in the meantime disappeared the breathing became almost normal, and the patient a mental attitude was very much brighter. A second infusion was given, however and some hours later the blood carbon dioxide was 30.85 millimeters. His further treatment was continued by the metabolism department. He was fasted until sugar-free his readings averaging 36 millimeters during the fasting period. His course was complicated by the development of numerous abscesses which slowly cleared up but he was discharged after 53 days with the note that the patient remained sugar free on 500 grams of fat 90 grams of protein, 25 grams of carbohydrate, but with slight ketonuria still present. Blood sugar returned to normal. Clinically the patient was in good general condition.

#### RELATION OF ACETONE AND DIACETIC ACID IN THE URINE TO PLASMA BICARBONATE

For a number of years it has been a well known fact that acetone or diacetic acid or both are present in the urine of a certain number of patients before undergoing operation, and to an increased extent, both as to

quantity and frequency after operation. The clinical tests for these two substances are of such simplicity of technique that often surgeons and laboratory men have been wont to determine the presence of acetone or diacetic acid and draw their inferences or conclusions as to the so-called state of acidosis from the urinary findings. Since the literature on the subject of postoperative acidosis has been based largely on urinalysis it seems advisable to review briefly some of the opinions of the workers in this field.

Levison states 'When acetone is present before operation, the organism may be able to take care of the anæsthetic without disastrous results but when diacetic acid is present before operation the condition is aggravated and frequently results in acid intoxication.' He advocates postponing operation on patients having acid bodies in the urine until they have been eliminated by treatment. This author concludes his paper by advocating glucose by rectum or intravenously after operation, and says at times when sodium bicarbonate treatment is persisted in it appears to accomplish definite results (6).

Russ states The appearance of acetone bodies in the urine indicates a serious perversion of a patient's metabolism, and strongly contra indicates the administration of a general anæsthetic, until by appropriate treatment the patient becomes able to tolerate the anæsthetic and stand the operation. This same author in a series of 34 cases concludes that among the various warning signs of an impending acidosis including peculiar sweetish breath unreasoning dread of operation etc. is the presence of acetone and diacetic acid in the urine. He advocates sodium bicarbonate or sodium citrate by mouth with high carbohydrate diet, 'to cause a disappearance of the symptoms and to render the patient a safe subject for anæsthetic and operation' (7).

A more recent contribution to the subject is a report of 138 cases in which Quillian affirms that the acidosis factor was considered. The laboratory work in this series consists of a routine preliminary examination for diacetic acid and whether an acidosis was present or not, sodium bicarbonate and

dextrose have been given as a routine preliminary preparation for operation. No tabulated laboratory results are given. Very few of his cases suffered 'nausea of any consequence.' Only 5 cases had postoperative shock sufficient to cause anxiety and above all there was no mortality. Chronic appendicitis gynecological repairs and hernia repairs constituted over 80 per cent of his operations with a conspicuous lack of any gastro-enterostomies general peritonitis brain or spinal cord operations. In this series there was a large percentage of women who according to general observations run a vastly higher percentage of anteoperative acetone and diacetic acid than men. The conclusions which this author says are naturally deducted are (1) acidosis has a dominating influence in surgery (2) by preliminary and postoperative treatment, acidosis may be eliminated (3) postoperative discomfort and nausea, is greatly diminished by liberal preliminary use of sodium bicarbonate (4) surgical shock may be avoided by preventing acidosis, and by rapid, careful technique in operative procedures.

The most extensive work done on the subject of acetone and diacetic acid in the urine of patients before and after anæsthesia, had been by Bradner and Reiman. In a series of 214 cases they showed that acetone appeared in 23 per cent of the cases before operation, and in 67 per cent after operation while diacetic acid appeared in less than 1 per cent of the cases before operation, and in 17 per cent after operation. Their findings without regard to any theory in regard to acidosis are summed up as follows (1) Temperament of the individual, length of time the pre-operative treatment (nothing by mouth, and saline by bowel) had been carried out, appeared to have a slightly positive effect on acetone elimination (2) Acetone and diacetic acid are eliminated oftener and in larger quantities in women. (3) Surgery alone increased the acid the gravity of the operation and the severity of the pathology the amount of obvious shock, had but little bearing on the amount of eliminated acid, and the time of elimination.

In connection with the effect of surgical

TABLE II.—PERCENTAGE OF CASES SHOWING ACETONE AND DIACETIC BEFORE AND AFTER OPERATION WITH THE VARIOUS ANÆSTHETICS

Anæsthetic	N Cases	Before and After Operation	Acetone		Diacetic	
			No. Cases	Per Cent	No. Cases	Per Cent
Gas and ether	40	Before		5	7	7.5
		After	27	68	26	65
Gas and oxygen	3	Before		30		0
		After		60	2	6
Open ether		Before		9		
		After				22
Local	7	Before				
		After	5			43
Chloroform		Before				
		After			4	66
Total Average	86	Before	20			3
		After	4	7	1	16

operation and anæsthesia on the alkaline reserve of the body we decided to test the urine before and after operation for acetone and diacetic acid. These tests were made along with the routine ante and postoperative analyses. The tests selected were Legal's test for acetone and Arnold's test for diacetic acid which are simple and unmistakable. The varying intensity of these reactions has been used as a rough estimate of the amount of acetone and diacetic acid ranging from a very faint trace to a very heavy trace.

These tests have been carried out in 86 cases which received no alkaline treatment to determine the effect of various factors on acetone and diacetic acid eliminated. The various anæsthetics, the length of anæsthesia, the gravity of the pathological condition, the severity of the operation, the age and sex of the individual and the relation of the blood carbon dioxide to the acetone and diacetic acid excretion were in turn considered.

It was determined that 23 per cent of all patients showed acetone in their urine immediately before operation and 13 per cent showed diacetic acid. The relatively high percentage before operation is quite probably due in a measure to the withholding of food in

the preparation for operation. After operation, 72 per cent of the patients showed acetone and 56 per cent showed diacetic. The results with the various anæsthetics including local anæsthesia, held very close to this average as may be seen in Table II. The chloroform series should in a measure, be considered apart from the others. It will be noted that none of the patients showed either acetone or diacetic acid before operation. In explanation of this it can be said that these patients for chloroform were naturally carefully chosen. More than half of them were men with hernia repair operations. The women consisted of 3 appendectomy cases, a tracheoplasty and a lymphadenectomy. None of these patients was at all sick before operation. It is noteworthy that 91 per cent showed acetone postoperatively and 66 per cent showed diacetic acid postoperatively although the decrease per 10 minutes in carbon dioxide tension during the operations is the same as in the gas and oxygen series, and less than in the other series. Although the percentage of cases showing acetone and diacetic acid postoperatively is high with chloroform both of these substances were present in very small traces in every instance. The series is, however, rather small from which to draw any definite conclusion.

The length of operation and anæsthetic apparently had no relation to the presence or amount of acetone and diacetic acid. Some of the longest cases in the gas and ether series, e.g., one of 10 hours and 13 minutes and another of 3 hours, showed no acetone nor diacetic acid in the postoperative urine while cases of 14 and 15 minutes respectively showing neither acetone nor diacetic acid before operation showed both afterwards. The same holds true for the open ether and local anæsthetic series. In the chloroform series the only case not showing acetone and diacetic acid postoperatively was 1 hour and 2 minutes while the shortest case of 38 minutes showed both. In the gas and oxygen series the average elimination of acetone and diacetic acid after operation was less for the cases over 45 minutes than for those under 45 minutes.

The gravity of the pathological condition and the severity of the operation likewise

apparently had no effect on the acetone and diacetic acid elimination. We found that following such an operation as an exploratory craniotomy for brain tumor, a gastro-enterostomy for carcinoma, a nephrotomy and an exploratory laminectomy, there was no acetone nor diacetic acid while following a dilatation and curettage, a hernia repair, an osteotomy for hallux valgus and a clamp and cautery for hemorrhoids, the profoundest traces of acetone and diacetic acid were noted.

In regard to the relation of blood carbon dioxide to the acetone and diacetic acid eliminated, the following observations were made. We took as an arbitrary standard of alkalinity before operation 40 millimeters carbon dioxide and 35 millimeters carbon dioxide at the end of operation and on that basis prepared Table III.

TABLE III.—RELATION OF BLOOD CARBON DIOXIDE TO URINARY ACETONE AND DIACETIC ACID

BEFORE OPERATION	Acetone		Diacetic Acid	
	Number Cases	Pct Cent	Number Cases	Pct Cent
Blood CO <sub>2</sub> 40 mm. or higher	3	65	7	63
Blood CO <sub>2</sub> under 40 mm.	7	35	4	37
AFTER OPERATION				
	Number Cases	Pct Cent	Number Cases	Pct Cent
Blood CO <sub>2</sub> 35 mm. or higher	11	56	7	37
Blood CO <sub>2</sub> under 35 mm.	27	44		43

From this table it is seen that acetone and diacetic acid appear if anything more often when the blood carbon dioxide is high than when it is low. If they are present when the blood carbon dioxide is less than 35 millimeters they are apt to be in heavier traces than when they appear above 35 millimeters. Not infrequently with a reading as low as 30 millimeters there is no acetone nor diacetic acid. In going carefully over the various anæsthetic series we find that there is no constant relation between the blood carbon dioxide and the acetone and diacetic acid in urine.

As regards the relation between nausea and vomiting and the elimination of acetone and diacetic acid we found that 73 per cent of the cases showing postoperative nausea and

vomiting showed acetone and diacetic acid in the urine while 77 per cent of the cases with no nausea and vomiting had acetone and diacetic acid.

Age does not seem to appear in any way as a factor in the elimination of acetone and diacetic acid. Sex however plays a most important part, as is seen by Table IV. Not only is the percentage of women showing acetone and diacetic acid before and after operation appreciably higher than that of men but the amount of acetone and diacetic acid is almost invariably greater in the women.

TABLE IV.—DISTRIBUTION OF THE CASES ACCORDING TO SEX

	Cases	Men	Women
Gas and ether	40	8	8
Gas and oxygen	3	0	4
Open ether	4	4	5
Chloroform		7	0
Local	7	0	0

	ACETONE Pct Cent						DIACETIC Pct Cent					
	Gas and Ether	Gas and Oxygen	Open Ether	Chloroform	Local	Total	Gas and Ether	Gas and Oxygen	Open Ether	Chloroform	Local	Total
Before Operation												
Men	3	33	50	0	6	8	4				10	8
Women	18	5	20		00	0	33					8
After Operation												
Men	45	66	00	85	80	62	45	55	4	40	4	4
Women	95	73	60	00	100	84	88	75	40	00	00	76

By referring to the legend above it is seen that only one woman was followed under local anæsthesia, thus the impression conveyed by 00% may be erroneous.

In view of the fact that it has been stated that the presence of diacetic acid in the urine is a contra indication to operation until the condition has been remedied by suitable treatment, a careful study of the 11 cases in our series showing diacetic acid before operation was made. Eleven cases were chosen at random which showed no acetone nor diacetic acid before operation for comparison. Care was taken to have the percentage of women equal in both series.

	Average CO <sub>2</sub> Tension before Operation	Average CO <sub>2</sub> Tension after Operation
Cases with diacetic acid in the ante-operative urine	4.3	34
Cases with neither acetone nor diacetic acid in the ante-operative urine	4.8	37.8



The diminution in plasma bicarbonate in the cases with diacetic acid was 7 millimeters, as contrasted with 5 millimeters in those with neither acetone nor diacetic acid but did not approach a pathological acidosis. In all these cases showing diacetic acid the condition of the patient under anesthesia after operation and during convalescence was good.

#### TREATED CASES

In 13 cases receiving 20 to 40 grams of sodium bicarbonate in the 12 hours prior to operation the ante-operative urine showed neither acetone nor diacetic acid, while 76 per cent showed acetone postoperatively and 69 per cent showed diacetic acid. The elimination of acetone and diacetic acid postoperatively with none in the ante-operative urine, was accompanied by a greatly increased alkalinity of the blood up to 53 millimeters or even 59 millimeters in some cases. Whether the failure of acetone and diacetic acid to appear in the ante-operative urine of these cases has any relation to the treatment administered or is simply a coincidence, we are unable to state.

In 9 cases which received 20 grams of sodium bicarbonate in 500 cubic centimeters of 4 per cent glucose solution immediately after operation, we found the elimination of acetone and diacetic acid only slightly different from that of the untreated cases. The carbon dioxide tension in this series was well over 40 millimeters and in one case, as high as 54 millimeters in the blood taken after operation. These treated cases followed closely the untreated cases in all respects except the high carbon dioxide tension.

#### URINALYSIS ON TREATED CASES

		Acetone		Diacetic Acid	
		Number Cases	Per Cent	Number Cases	Per Cent
Cases receiving treatment before operation	Ante operative urine				
	Post operative urine	20	76	9	69
Cases receiving treatment after operation	Ante operative urine	3	33		00
	Post operative urine	5	55	4	44

#### SUMMARY AND CONCLUSIONS

1 In the average case undergoing operation, not showing glycosuria, very marked ketonuria nor acidemia before operation the degree of acidosis induced is negligible, and the choice of anesthetics so far as the question of acidosis is concerned, is irrelevant.

2 None of the symptoms observed in the routine postoperative course is due to the slight diminution in alkalinity of the blood and tissues induced by the preparation, anesthesia and operation.

3 With the exception of one diabetic patient with obvious severe acidosis before operation, not one case in 120 showed an acidosis either from a clinical or laboratory standpoint, approaching dangerous proportions.

4 Acetone and diacetic acid occur in the urine of a certain percentage of patients undergoing operations, and in greatly increased percentage and amounts after operations.

5 The presence of acetone and diacetic acid apparently has no relation to the gravity of the operation or the seriousness of the pathological condition, to the length of anesthesia, nor to postoperative nausea and vomiting.

6 No relation can be determined between the alveolar carbon dioxide tension and the acetone and diacetic acid elimination, neither in the untreated nor carbonate treated cases the latter having shown acetone and diacetic acid in the presence of high blood alkalinity.

7 Diacetic acid in the urine is not necessarily a contra indication to operation.

8 Women show larger percentages and amounts of acetone and diacetic acid both before and after operation, than men.

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RESULTS FOLLOWING THE TREATMENT OF PELVIC INFLAMMATORY LESIONS BY SURGICAL MEASURES<sup>1</sup>

By JOHN G. CLARK, M.D. AND CHARLES C. NORRIS, M.D. PHILADELPHIA

ALTHOUGH for several years the general tendency in the treatment of pelvic infections has been progressively conservative it was owing to Simpson's accurate clinical observations and logical conclusions that the attention of American surgeons has become focused upon the necessity for adopting this vital policy. With absolute rest in the Fowler posture, careful regulation of the gastro-intestinal function, the administration of diuretics, the use of hot douches and of hot or cold applications to the lower abdomen, the temperature declines, the pulse drops to normal, the peritoneal symptoms subside, and the patient gradually becomes free from pain. Under this plan of treatment, fallopian tubes that are greatly enlarged usually diminish in size until they are no longer palpable. If the inflammatory attack is a primary one and especially if it occurs in young women in whom acute gonorrheal infection is so frequently found, it is our policy to permit the patient to return to her home with the strict injunction, however, that if a subsequent attack occurs she is to return to the hospital at once. In several of our cases patients remained free from recurrences and apparently are restored to normal health. Of course such cases are the exception for in the majority a recurrence will sooner or later take place. When this does occur the same plan of treatment is pursued as in the primary attack, but when the symptoms again subside operation is urgently advised, acting on the principle that there will be repeated exacerbations of a persistent infection which will exert a more and more destructive effect on the pelvic tissues with each recurrence.

The rule adopted by us as to the length of time the patient is to be kept in bed is some

what at variance with that regarded by Simpson as essential. In the average hospital the ward accommodations are not sufficiently ample to permit these patients to be kept under treatment for an indefinite time. We find it practically impossible to keep such patients in a free bed until the temperature remains normal and is not affected by a bimanual examination or by walking about the ward, and we believe that our statistics warrant us in thus modifying this rule. The underlying principles that serve to guide us, however, are essentially the same as those enunciated by Simpson.

The patient is kept in bed until the acute process subsides and the mass decreases in size or becomes less hyperæsthetic. The temperature must fall to within a degree of normal and must remain there for at least three to five days before we consider the time for surgical intervention opportune. According to our observations a patient may remain in the hospital for several days or even for weeks before she can be said to have reached the ideal stage insisted upon by Simpson. It is our experience that under so rigid a régime the patient becomes restless and most importunate in her demands to be permitted to leave the hospital. The complete relief of all symptoms is often the incontrovertible argument advanced against a surgical operation. Why should I undergo an operation when I am already well? is a question that is difficult to answer to the patient's satisfaction. We have therefore stopped short of the ideal, and have adopted a semiconservative method which consists in following the waiting policy until one of two conditions is reached. In some cases the infection does not subside, but, instead, the pelvic mass grows larger until it may reach a considerable size under these con-

<sup>1</sup> In previous paper, "Conservative Surgery of the Pelvic Organs in Cases of Pelvic Peritonitis, etc.," *Surg., Gynec. & Obst.*, 9, 4, pages 406-411, we described the operative methods employed by us. Especial stress was there laid upon the absolute necessity of placing the converted ovary in a normal anatomic position, carefully preserving the circulation of the structure, and shielding it from every possible surgical traumatism. It is upon the observance of these precautions that the good results of conservative operation are largely dependent.

ditions we deem surgical intervention advisable. If the mass is easily reached through the vagina, we establish adequate drainage through this avenue, and if the symptoms subside and the patient gets well no further steps are taken. In at least 65 per cent of cases no further surgical treatment is necessary in the remainder however the pelvic symptoms after the drainage of the abscess may be so persistent as to make an abdominal operation necessary. If the slightest doubt exists as to the possibility of a safe approach through the vagina in reaching the purulent focus we make an abdominal incision and thus effect a complete orientation of the pelvic pathologic lesions. If the small intestine is so situated as to render vaginal drainage hazardous we then resort reluctantly to the abdominal drain but, fortunately this necessity has been very rare. In our experience less than 5 per cent of the most exaggerated pelvic infections are drained through the abdominal incision the celiotomy being performed merely as an aid to inspection and palpation thus rendering it possible to make the vaginal incision safe and adequate for complete drainage purposes. The method of vaginal drainage is a natural one for when the sitting posture is assumed purulent matter makes its exit by gravity and is not dependent upon the feeble capillary action of gauze or rubber tissue in sponging it from a deep pocket.

Under the waiting policy the great majority of cases undergo gradual subsidence the inflammatory mass decreases in size the acute hyperaesthesia largely disappears the intense cellular infiltration adjacent to the pyogenic focus becomes absorbed and the connective tissue is restored to a normal pliability. As Saenger has so aptly put it, we are then in a position to remove the debris of the storm without inflicting injury on the adjacent normal or barrier tissue. The only departure therefore that we make from Simpson's rule is that of not insisting upon the subsidence of all the local and constitutional symptoms of the primary infection. We believe the safety and advisability of this middle-of-the-road policy are fully sustained by the results achieved in our cases.

TABLE I—RESULTS OF 308 OPERATIONS FOR INFLAMMATORY DISEASES OF THE PELVIC ORGANS (TABULATED ACCORDING TO PURULENT AND NON PURULENT LESIONS)

OF TOTAL OF 308 CASES, 174 HAVE BEEN TRACED			
	Purulent Lesions Regardless of Type of Operation	Non purulent Lesions Regardless of Type of Operation	Total Number of Cases
Total number operated upon	37		308
Total number of cases traced	78	96	74
Cured	30 (38.5%)	7 (7.2%)	37 (50%)
Improved	34 (43.5%)	3 (3.1%)	37 (50%)
No change	1 (1.3%)	1 (1.0%)	2 (2.7%)
Wrote	1 (1.3%)	1 (1.0%)	2 (2.7%)
Deaths (made no hospital record from all causes)	1 (1.3%)	1 (1.0%)	2 (2.7%)

The deaths prior to the total number of surgical cases—308. Actual primary mortality is 1.6 per cent, the fatalities all occurring among the purulent infections. Among the non acute, chronic, and quiescent inflammatory lesions no fatality occurred.

In our endeavor to arrive at a positive opinion as to the relative results following operation in the purulent and non purulent lesions of the pelvis we have disregarded the clinical diagnosis and have classified the conditions according to the microscopic findings reported from our departmental laboratory. Thus there can be no question as to the accuracy of the diagnosis. As will be seen from Table I the results are decidedly in favor of operation in the non purulent cases for of 137 purulent cases operated on, 64 per cent were cured and only 3 died—a fraction over 1 per cent whereas in the 171 non purulent cases 74 per cent were cured and no fatality occurred. Although a complete statistical study of wound healing has not been made, the advantage is nevertheless decidedly in favor of the non purulent cases. From this study alone it must be conceded that in infections of the fallopian tubes, a conservative waiting policy offers every advantage to the patient. In passing it may be said that not a single patient has died during the course of this conservative treatment.

In Table II we have made a comparison between a series of 321 cases (Series A) operated upon before 1910 and 195 cases

TABLE II—COMPARATIVE STATEMENT OF THE RESULTS OF CONSERVATIVE OPERATIONS

Under this heading are classified those cases in which the uterus and one or both ovaries have been conserved, thus permitting menstruation to continue. The majority of these patients have been rendered sterile by bilateral salpingectomy which includes excision and occlusion, by suture, of the cornual portion of the tube.

	Series A (Before 1910)	Series B <sup>a</sup> (Since 1910)
Total number of cases	321	195
Total number of cases traced	302	90
Cured	137 (67 8%)	58 (64 4%)
Improved	39 (19 3%)	24 (26 6%)
Not improved	12 (5 9%)	3 (3 3%)
Worse	7 (3 4%)	2 (2 2%)
Deaths	7 (3 18%)	3 (3 5%)

In Series B more or less pain traceable to the conserved ovary occurred in 6 cases; of these, the pain was mild in 4 and severe in 2. In 4 a second operation was required for the removal of ovarian tissue.

(Series B) treated surgically since 1910. The results in both series run closely parallel except as regards the mortality. In our first series the surgical death rate was 2.18 per cent in the second 1.5 per cent. This difference may probably be accounted for on the ground that in our second series greater care was exercised in following the conservative policy. No great stress however is laid upon this difference for so small a ratio between the two may be the result of accidental discrepancies. Since 1910 relatively fewer cases have been subjected to operation for a larger number have been permitted to leave the hospital without operation, since we are gradually extending our conservatism to the point of withholding surgical intervention until a second attack has occurred. We pursue this policy without hesitation for we are convinced as the result of a decade of observations that these patients are subject to almost no risk by deferring operation since the danger incident to these infections stands in no similar relationship to that of infection of the vermiform appendix. It is also of interest to note that the number of operations for the removal of conserved ovaries has been necessary in only four cases. Of those patients whom we have traced since their discharge from the University Hospital not one has been operated on in any other hospital. Of the conservative cases a larger percentage continue to suffer with pelvic ailments than of those cases in which a radical operation has been performed and the ovaries and uterus removed. This is of course, to be expected for in almost every conservative

TABLE III—COMPARATIVE STATEMENT OF RESULTS OF HYSTERECTOMY

Series A (Operations performed before 1910)		
Total number of cases	100	
Deaths	6 (6%)	
Series B (Operations performed since 1910)		
Total number of cases	113	
Pyogenic cases (majority chronic)	67	
Total number of cases traced	83	
Cured	63 (76%)	
Improved	18 (21 9%)	
Unimproved	1 (1 1%)	
Worse	1 (1 1%)	
Death	0	
	Artificial menopause	Average age
No symptoms	13	34.1
Mild symptoms	52	32.18
Severe symptoms	18	31.9

operation some pathologic tissue is left behind, and if the infection does not become quiescent and the tissue return to the normal it will continue to cause more or less painful symptoms. The nearer the patient is to the menopause, the more radical should the operation be, but, unfortunately the large majority of these infections occur in young women in whom it is so necessary to conserve ovarian tissue.

In Table III we have made a comparison of those cases—115 in all—upon whom a hysterectomy was performed. In this group were represented the more extensive inflammatory lesions. In Series A the 100 cases operated upon before 1910 the mortality was 6 per cent, whereas in Series B the 115 operated on since that time the mortality was nil. This striking difference in results must be again attributed to our insistence upon a careful preparatory treatment. In the first series (A) a greater number were operated upon within a day or two after their admission to the hospital whereas in the second series (B) almost all were kept under careful observation a few to several days until the temperature had declined to nearly a normal level and the acute symptoms had subsided.

#### CONCEPTION IN CONSERVATIVE CASES

Under this heading are placed those cases in which the uterus and one tube and one

ovary (not necessarily on the same side) have been conserved in married women under forty years who have been operated upon at least one year previous to our investigation.

Total number	29	
Births	( cases, labor normal in both)	
Miscarriage	1 (due to a fall.)	

#### SALPINGOTOMIES

Total number	8
Conception	0

In considering the last two groups cognizance should be taken of the fact that not every marriage is fertile that of sterile marriages the man is at fault in a definite proportion (33 per cent) and that in many cases the disease is of gonococcal origin, presumably in the majority in women, the result of marital infection. In such marriages the proportion of sterile husbands is, therefore, greater than among a group of normal men. Moreover a certain proportion of these patients employed means to prevent conception for some time following operation. Furthermore, possibly five years hence, some of these cases now classed as sterile may become fertile. The number of salpingotomies is too small to permit conclusions to be drawn but the results tend to confirm our previously expressed opinion regarding the small likelihood of conception occurring following this operation. Among 8 salpingotomies 7 complained of more or less pain, whereas among 51 bilateral salpingectomies 41 were cured and 9 improved (1 death).

As the result of our observation of these cases but one conclusion can be reached, and that is that in all inflammatory cases sterility is the rule, and it is only in the exceptional case that impregnation occurs. In such instances we maintain the hope that, as the result of a conservative operation, the patient may return to fecundity—a hope however that is but seldom realized. It is the physiologic effect of the retention of the ovaries rather than the restoration to fecundity that influences us in favor of conservatism. If after a careful balancing of the pathologic equation, we are still in doubt as to the advisability of performing total extirpation of the ovarian tissue, we pursue the conservative policy believing as we do

that it is better to reoperate radically in the occasional case of failure to relieve the patient, than to pursue a radical extirpative policy from the beginning. Our conviction concerning the vital necessity of preserving ovarian tissue is at variance with that of Graves, who does not attach so much importance to the physiologic influence of the ovary. Certainly our cases have not given us so favorable a view as he holds concerning the comparative freedom from serious nervous symptoms in the younger women.

TABLE IV—SYMPTOMATOLOGY SUMMARIZED FROM 100 TYPICAL HISTORIES OF PELVIC INFLAMMATORY DISEASE

	Per cent
Pelvic pain	90
Dysmenorrhea	30
Irregular and too profuse menstruation	4
Leucorrhoea	36
Frequency of or burning on micturition	10
Constipation	30
Nausea or gastric disturbances	26
Headache	4
Backache	30
Nervousness	6
Loss of weight	
Sterility (as a chief symptom)	2

In Table IV we have taken up in the order of their frequency the various symptoms from which these patients suffer. It is interesting to note that 42 per cent complain of irregular and too profuse menstruation. This symptom we attribute to the influence of a disordered ovarian function rather than to an endometritis which so many writers believe is the underlying cause of this functional menstrual disturbance. Endometritis cannot, of course be ignored as a possible cause for irregular bleeding but we incline to the view that the disturbing influence chiefly emanates from the irritated ovary.

TABLE V—ULTIMATE RESULTS BASED UPON THE AGE OF PATIENTS IN INFLAMMATORY CASES

	Years
Average age of all patients.	35
Cured (all types of abdominal operations)	31+
Improved.	7+
Not improved.	34+
Worse	3+

According to our preconceived ideas we have assumed that the curative effect of an operation would increase in exact ratio to the

age of the patient. In this assumption we were apparently mistaken for in an analysis of our results we find that the age factor plays practically no part. In other words the older woman is just as likely as is the younger woman to secure an unsatisfactory cure. This applies especially to conservative cases and for this reason as has previously been stated in women over thirty years of age, we lean toward a more radical policy when there is any question as to the advisability of performing the more radical operation. In younger women we err more frequently on the side of conservatism and for very obvious reasons preferring to resort to a second operation in case of failure of the first. It is also a somewhat noteworthy fact that all the inflammatory cases combined averaged as high as thirty-one years of age. This observation is also opposed to our previous assumption, for prior to our investigation we believed that the large number of much younger women infected by the gonococcus would reduce the average age to less than thirty years. This result of our study is nevertheless somewhat comforting in so far as it indicates that the more radical procedure which we so strenuously abjure in young women, is really less frequently necessary than we had formerly believed. We feel assured that when the sexual function has been fully established in women past twenty-eight or thirty years of age the danger of serious neurosis and sexual disturbances developing is much less than in the young unmarried females who have fallen victims to a gonococcal infection. We have usually found that where complete sexual apathy has existed or a serious dyspareunia has developed in married women who had previously been quite normal so far as sexual inclinations were concerned, the sexual function was fully restored even after complete removal of the ovaries and uterus. This is of course, by no means a constant rule and is dependent to a large extent upon individual temperament. Given a woman of limited *libido sexualis* removal of the ovaries almost invariably abrogates all sexual desire. Conversely in a woman of ardent *libido sexualis* when the function has been suppressed

because of the pain incident to a dyspareunia the result of pelvic inflammatory disturbances relief of this pain by operation even when the ovaries and uterus have been removed may be followed by the return of a strong sexual inclination. The bearing these operations have upon the sexual habits of women is difficult of analysis for this instinct varies so widely even in relatively normal women as to preclude any satisfactory estimate in the subjects of inflammatory infections. We are assured of one fact however and that is that in women between eighteen and twenty-five years of age there is almost invariably a decided atrophy of the vaginal tissues giving rise to marked diminution in the caliber of the vagina. In women who have not borne children this shrinkage is so great as almost invariably to cause so severe a dyspareunia as to abrogate all sexual relations. Even where there is a considerable relaxation of the pelvic floor in married parous women owing to this climacteric atrophy we seldom perform a coincident perineal repair because of the certainty that this additional operative procedure will in many instances lead to serious dyspareunia. In these cases when ovarian tissue is conserved even though a hysterectomy has been performed this sequel seldom follows.

TABLE VI.—COMBINED OPERATIONS IN PELVIC INFLAMMATORY CASES

Total number of cases	308
Combined plastic and abdominal	59
Coincident appendectomy	120
Other combined operations for biliary and other upper abdominal lesions	18

In the presence of a purulent lesion in the pelvis intra abdominal manual examination of the organs of the upper abdomen is omitted. Owing to the juxtaposition of the right fallopian tube with the appendix, there is usually a periappendicitis or appendiceal adhesions. In all such instances the appendix is removed. Even though the symptoms of a lesion in the upper abdomen are marked the hand is not passed up into the area through the incision unless the pelvic inflammatory lesion is absolutely quiescent. If there is an active infection in the pelvis it is

safer to wait for a more propitious time for performing an operation in the upper abdomen.

As regards surgical intervention in cases of acute pyosalpinx, we feel constrained to record a very decided criticism of a recent article by Coffey.<sup>1</sup> Surgical Treatment of Acute Gonorrheal Tube Infections with a Quarantine Pack. In this article he reverts to principles long since declared obsolete by the great majority of leading gynecologists and many general surgeons. The placing of a large pack in the pelvis through a long ventral incision is open to so many serious objections that we believe it should be unconditionally condemned. In the first place Coffey assumes that, as a result of this method he has actually caused the subsidence and effected the possible cure of a gonorrheal salpingitis. It has been proved beyond reasonable doubt that the opening of a fallopian tube in either an acute or a chronic state of inflammation in the belief that its anatomic structure will be restored to normal is fallacious. In those pyogenic infections exclusive of the gonococcal type that terminate in an abscess a free opening with drainage will usually effect a functional cure for the infecting micro-organism has now run its course and is generally dead. Not so however with the gonococcus, which may remain latent indefinitely drainage of the abscess merely tiding the patient over an acute exacerbation. It requires no prophetic vision to forecast the result in a hundred cases treated according to Coffey's plan. In a considerable proportion of cases the large drain will inevitably weaken the abdominal wall and as a sequel a considerable percentage of hernias must follow. Notwithstanding Coffey's contention to the contrary the presence of so large a foreign body will certainly give rise to innumerable adhesions among the dependent loops of the ileum thus promoting distressing postoperative symptoms during the earlier convalescence and will continue as a threatening portent from obstructive possibilities during the more remote periods, after the patient has been discharged from the surgeon's care. The title quarantine pack is a misnomer for

It does not quarantine the gonococcal infection since, from its very nature, the infection is usually localized strictly to the pelvic organs. A general gonorrheal peritonitis is so rare a condition that it is difficult to collect even in our voluminous surgical literature a sufficient number of cases from which to draw conclusions as to its true nature. The very paucity of the cases reported in the literature on this subject is a positive argument against Coffey's so-called quarantine pack. Moreover the pack does not even free the tubes of the infection. One striking peculiarity of the gonococcus is that, although it is a self localizing organism, it does not die but may remain dormant for months or even years and again spring into active growth. In other words Neoggerath's theory. One infected always infected has become a well-established fact. We feel that our statistics and the innumerable papers that may be found in the literature of recent years leave little room for argument in favor of Coffey's position.

The etiology of postoperative adhesions has been most comprehensively investigated, both in the operating room and in experimental laboratories and it has been proved beyond all doubt that foreign bodies of all kinds be they guarded as they may will result in the production of adhesions. Notwithstanding these observations Coffey asserts that a pack arranged as he suggests will prevent the formation of adhesions. To the contrary we believe that when he opens a gonorrheal tube in which nature is truly quarantining the infectious matter he has, by means of his drain, established a most effective way for distributing the purulent matter over a fresh abdominal wound also by capillarity and continuity of surface the drain conducts the infective material by means of his pack to the immediately adjacent peritoneal environs where it acts as an acute irritant causing exudation of serum and the formation of plastic lymphobasal conditions for the production of intestinal adhesions.

From our clinical observations in the large series of cases that we have studied, we believe that Coffey's plan is a very

hazardous one reverting to a policy that if adopted generally would carry us back to the methods of twenty years ago

#### CONCLUSIONS

1 From a study of more than 500 cases in which the postoperative and remote results of surgical intervention in pyogenic infections in the fallopian tubes were considered we conclude that a course of conservative preparatory treatment decreases mortality and enhances the chances for securing a good functional restoration of the pelvic organs.

In all cases of acute infections of the fallopian tubes the patient should be kept under observation until the course of the case is defined. (a) In the greatest majority the temperature subsides the pain disappears the tubal enlargements decrease to impalpable proportions and if the attack is a primary one the patient may be given a respite from operation until a recurrent attack supervenes. Even under these recurrent conditions the conservative policy is again pursued until subsidence takes place a second time, when an abdominal operation is advised with a view to treating existing conditions to the best possible advantage. Usually both tubes are removed and the ovaries are conserved. (b) If under the conservative plan the symptoms do not abate and the tube continues to enlarge, vaginal drainage is instituted either by direct incision into the cul de sac or through the guidance of an abdominal incision.

3 In the purulent lesions of the tube, all operative procedures are attended with a higher mortality and a greater morbidity whereas under a conservative waiting treatment a patient will seldom die during an

acute infection. In our series there was no death. In all hazardous cases the increasing severity of the symptoms and the enlargement of pelvic masses give ample warning and permit of a simple drainage operation that will tide the patient over the danger.

4 When the acute attack has subsided the surgeon has the best opportunity for ascertaining during the course of an operation the exact degree of involvement of the tissues and thus he is enabled to select the type of operation best suited to the individual patient.

5 Conservative operative procedures instituted with a view to restoring a closed fallopian tube seldom restore fecundity. Plastic operations upon the fimbriated extremities of the fallopian tubes with a view to effecting restoration of fecundity are almost invariably failures and necessitate additional operations. We believe therefore that the safer policy usually is to remove the tubes by a wedge shaped cornual excision in all doubtful cases, thus disregarding any attempt at restoration of fecundity.

6 Hysterosalpingo-oophorectomy in sexually mature women the subjects of chronic infections of the uterus and adnexa is followed by a lower mortality and a greater certainty of restoration to health than are possible after conservative operations.

7 Conservative operations employed with a view to preserving ovarian tissue should be limited chiefly to women under thirty years of age.

8 The routine drainage of pus-tubes through an abdominal incision is an unsatisfactory procedure from every standpoint, and should not be resorted to if it can possibly be avoided.



## SPINAL ANÆSTHESIA

## ITS FIELD CONTRA INDICATIONS SELECTION

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SO much misconception is prevalent in regard to spinal anesthesia that it has failed to receive its merited position among other valuable anesthetics. This misconception is largely the result of reports of small series of cases in which this method has been proclaimed with undue enthusiasm or has received unwarranted condemnation. Reports of isolated cases in which the results have been unsatisfactory or disastrous in the hands of those trying the method for the first time have done much to discredit it. Several large series of cases have been reported in the last few years which represent years of experimental and clinical observation of the method and upon these should be based the true estimate of the value of spinal anesthesia. The general tendency has been to assume a more conservative attitude in regard to its use and to admit certain limitation and some objectionable features but practically all agree that it has a distinct field of usefulness. Thanks to Barker Babcock and others the technique has been developed to a fair degree of perfection but no single definite technique has been uniformly accepted and used. The various clinics using different solutions each requiring a slightly different technique. Familiarity with the different varieties of solution and the technique required for each and utilizing them in the field to which they are best adapted would bring about more uniformly good results.

During the past seven years spinal anesthesia has been used in this hospital more than 7000 times. Except during a brief period of experimentation in 1909 when different drugs and solutions of varying specific gravity were being used, we have confined ourselves to the use of stovain in a solution heavier than the cerebrospinal fluid. The technique has been previously described in detail.

The opinion that spinal anesthesia should not be used extensively by one who is not specially trained in the method has steadily grown with us. In the hands of the novice the percentage of failures and untoward effects is high and danger to life cannot be lost sight of. A comparative study of our early and more recent cases confirms this assertion. We found the percentage of failures for one of us having a large experience to be about 0.8 per cent and that for six different doctors of meager or moderate experience to be 6¼ per cent. The percentage of untoward effects maintain about this same ratio under similar conditions.

Realizing that our technique has not been sufficiently diversified to admit of the widest field of successful applicability of spinal anesthesia and admitting the possibility of a wider field of usefulness we offer the following observations on the use of spinal anesthesia solely from our own experience.

## FIELD

We are convinced that spinal anesthesia in the hands of one trained in the method has a field in which it is in almost every respect the anesthetic of choice i.e. for operations on the lower rectum and anus perineum, all genito-urinary operations except those involving the ureters and kidneys all varieties of hernia except those occurring above the umbilicus appendectomy and all operations on the lower extremities. In this group of operations the dose required is small and the drug is confined to the lower part of the subarachnoid space, thus rendering collapse and respiratory paralysis the only really dangerous complications practically impossible. The unfavorable postoperative effects usually seen following the use of spinal anesthesia for operations on higher regions of the body are so infrequent as to be almost negligible. The percentage of failures is practical

ly nil and in case they do occur the injection can be repeated without danger. With reasonable speed in operating the duration of anæsthesia will always be found sufficient if the dose has been properly chosen. The relaxation of the abdominal wall and of the vesical and anal sphincters is complete. This offers a distinct advantage in operations on the urethra, anus and rectum and in hernia. Owing to vasomotor paralysis and lowered blood pressure, hæmorrhage is much less than with other methods of anæsthesia. Anæsthesia is perfect and complete. We have on several occasions done high amputations on very old individuals with no evidence of operative shock. Symptoms of moderate shock sometimes develop after anæsthesia has disappeared, but it is always of a mild degree and we have never known it to be fatal. Spinal anæsthesia is very economical from the standpoint of time and assistance to say nothing of the comparative inexpensiveness of the solutions. The injection should not require more than one minute and anæsthesia is usually complete in two and one half minutes. The anæsthetist is then free to operate or to assist in the operation. An intelligent nurse will suffice to record the pulse and respirations and to be on the lookout for dangerous symptoms. In many of the minor operations it is possible to administer the anæsthetic and then to complete the operation entirely alone. I have done this on several occasions for uncomplicated inguinal hernia and many times for infections hæmorrhoids and other minor operations. This would be a distinct advantage in case of an emergency operation in the home when the surgeon is isolated from his usual corps of assistants.

In the list of operations (Table I) of this group done in this hospital there has been but one death. This death occurred during spinal puncture and before the stovain had been injected. But as spinal puncture is a part of the method we reckon its mortality with that of spinal anæsthesia. It is important to note that 26 different doctors took part in the administration of the anæsthetic in this series and that none of them had used spinal anæsthesia before coming here. The only

death occurred in the hands of one learning the method.

It has been a debatable point with us whether or not to include intra abdominal pelvic operations in the group mentioned above. Practically all of our pelvic operations have been done under spinal anæsthesia and we have found it eminently satisfactory but we hesitate to state that 'it is in almost every respect the anæsthetic of choice'. The chief advantages over inhalation anæsthesia are complete relaxation of the abdominal muscles requiring smaller incisions shallow

TABLE I

Appendectomy	451
Prolapse rectum	8
Stricture rectum	37
Hæmorrhoids	264
Fistula "	97
Perineorrhaphy	48
Curetting uteri	384
Operations on cervix	28
Rectovaginal fistula	5
Vesicovaginal fistula	4
Hernia—	
Inguinal	687
Femoral	17
Ventral	30
Inguinal adenitis	330
Circumcision	377
Interior urethrotomy	180
Exterior urethrotomy	135
Hydrocele	201
Prostate	7
Amputation of penis	15
Varicocele	18
Operations on testicle	21
Plastic on urethra	9
Lower extremities—	
Amputation	98
Fractures	130
Infections	482
Ulcers skin graft, etc.	362
Varicose veins	9
Wounds	66
Tumors	58
Osteomyelitis	42
Popliteal aneurysm	2
Operations on joints	24
Club feet	5
Cystoscopy, examination of fractures, vaginal examinations, repeated injections, emergency wounds, etc.	510
Total	5160

respirations and a contracted condition of the intestines which facilitates greatly their isolation from the operative area. Post operative distention is comparatively infrequent and when present is usually of a mild

degree. There are some distinctly objectionable features which are not present in the first group. The Trendelenberg position which is used in a high percentage of these operations adds an element of danger which is very real, from upward diffusion of the anæsthetic solution. All deaths we have seen in which spinal anæsthesia seemed to be a factor (4) except one, have occurred when the Trendelenberg position was being used. The only instances of respiratory failure (3) have occurred while the patients were in this position. Vomiting during operation has occurred in 9 per cent of cases in which it was used as against 4 per cent when not used. Vomiting is one of the most objectionable features as it almost invariably occurs in the very midst of the operation when the blood pressure has reached its lowest point. Nausea restlessness air hunger etc. occur more frequently than vomiting but from the same cause, and are distressing to the patient if not to the operator. With the Trendelenberg position the average drop in blood pressure is 20 millimeters mercury and may progress to a dangerous point. All cases of marked collapse we have seen occurred when it was in use. Headache backache and other unfavorable postoperative symptoms are more frequent and more severe than in the first group. The average duration of anæsthesia in this region is 55 minutes. In case of very long operations or the necessity for multiple operative procedures the duration of anæsthesia will sometimes be insufficient. One is usually able to work on the perineum and vagina some time after there has been return of sensation in the abdominal wound area. For this reason it is well to finish all intra abdominal work required first leaving operations involving the perineum vagina, and lower parts till last. When spinal anæsthesia is used routinely for pelvic work it is necessary to adopt a method of preparation of the patient which will require very little time, and to operate with reasonable speed. It is possible that Babcock's technique with solutions lighter than the cerebrospinal fluid would obviate some of the dangerous and unfavorable features caused by the Trendelenberg position. As yet we have not given it a

fair trial. Spinal anæsthesia could hardly be considered the anæsthetic of choice for operations in this region in the face of so many objectionable features. We have found it sufficiently satisfactory however to continue to use it routinely for all intrapelvic operations.

TABLE 2 — PELVIC OPERATIONS

Hy terectomy	341
Mvomectomy	
Tubes and ovaries	513
Suspension uteri	76
Total	990

NOTE. In many cases multiple operative procedures were carried out in each case. Only the most important is given. Each number represents separate case.

Spinal anæsthesia is not sufficiently satisfactory for operations on the upper abdomen and thorax to warrant its general use here. As most of the operations in this region require considerable time it is usually necessary to inject at the area of the cord directly supplying the operative field in order to obtain anæsthesia of sufficient duration. If the injection is made in the lumbar region and high anæsthesia obtained by diffusion upward from change in posture the anæsthesia will not only be very light but of very short duration. With the high injection the danger of collapse and respiratory failure are markedly increased. Vomiting is more frequent and more prolonged. In a fairly high percentage of cases the anæsthesia is not complete in the upper abdomen. While there is no pain during the abdominal incision pain and nausea are complained of and vomiting occurs when traction is made on the parietal and visceral peritoneum. The symptoms are not severe and will not interfere with the operation but the resulting shock seems to be out of all proportion to the degree of trauma. This shock added to an already lowered blood pressure may place the patient in a very dangerous condition. Part of the nerve supply to these structures comes from the lower dorsal nerves which are not always reached by the stovain. In spite of these disadvantages it is wise to choose spinal anæsthesia for operations in this region in selected cases. These will be spoken of under selection.

Operation on the upper thorax neck and

head under spinal anæsthesia with any technique yet developed is too dangerous. It should not be used.

#### CONTRA INDICATIONS

There are certain definite contra indications to spinal anæsthesia which deserve careful consideration. Those based upon the physiological action of intraspinal anæsthetics are most important.

As there is an almost constant drop in blood pressure of varying degree spinal anæsthesia should not be used in cases in which there is marked hypotension from shock, hæmorrhage, or any other cause. Moderate hypotension need not be considered a contra indication except in operations on the upper abdomen or higher. Operations on the perineum, rectum and lower extremities can be done safely even in the presence of marked hypotension but special care is necessary in dosage and supportive measures. In exceptional cases where spinal anæsthesia would be considered the anæsthetic of choice in spite of the presence of marked hypotension operation could be safely done by giving continually, during the operation normal saline containing adrenalin intravenously. This procedure seems to combat successfully the usual drop in blood pressure. The very old and æsthetic individuals from long continued illness seem to be unable to re-establish their blood pressure after a moderate drop. As a rule they should not be chosen for spinal anæsthesia, unless the operation is below the level of the pubis and a very small dose can be used.

Cases in which there is marked interference with free cardiac action should not be chosen, i.e. pericarditis, advanced myocarditis, mediastinal tumors and large pleuritic effusions displacing the heart. These cases almost invariably do badly under spinal anæsthesia.

Respirations are shallow and slow and the diaphragm plays an important rôle, so that spinal anæsthesia is contra indicated in any condition which interferes markedly with diaphragmatic breathing, i.e. extensive ascites, large intra abdominal tumors, large pleuritic effusions etc. This does not apply to operations below the pubis. There is one impor-

TABLE 3 —THORAX AND UPPER ABDOMEN

<b>Thorax—</b>	
Wire for fractured rib	3
Liver abscess	13
Empyema	3
Wounds	2
<b>Abdomen—</b>	
Gastro-enterostomy	2
New-growth	17
Wounds of stomach	4
Fistula	7
Splenectomy	4
Splenopexy	2
Peritonitis	21
Operations on intestines	50
Cholecystostomy	3
Nephropexy	8
Nephrectomy	3
Ureters — plastic	1
Umbilical hernia	5
Epigastric hernia	2
<b>Total</b>	<b>149</b>

tant exception to this general statement. In paralytic ileus after the injection of stovain the intestines tend to contract and the relaxation of the anal sphincter allows them to empty themselves so that the interference to respiration is quickly removed. This of course would not hold in mechanical obstruction.

Cases in which there is existing cerebro-spinal disease should not be chosen unless there are other conditions present which render spinal anæsthesia the anæsthetic of choice.

It is dangerous to use spinal anæsthesia when there is any likelihood of a convulsion occurring at the time of or shortly after injection, i.e. eclampsia, tetanus and hysteria. We have observed one death which occurred in an eclamptic convulsion in a woman who was given stovain, preparatory to doing a cesarian section. If spinal anæsthesia is especially indicated in any of these conditions as it probably always is in eclampsia, measures should be taken to avoid the occurrence of convulsions at the time of operation.

Although we have used stovain in children quite extensively we have not found it very satisfactory. Considerable difficulty is usually encountered in trying to effect lumbar puncture, due to resistance on the part of the patient. This may result in undue trauma to the cauda equina. The percentage of failures is higher than in adults and on a few

occasions it has been necessary to give a general anæsthetic even with perfect anæsthesia on account of extreme restlessness and nervousness. It is probably better to confine the use of spinal anæsthesia to the selective field in children.

Extremely nervous individuals and those who are prejudiced against the method had better be excluded.

Marked deformity of the spinal column is not necessarily a contraindication to spinal anæsthesia. Of course if the deformity is so marked that spinal puncture cannot be done, it cannot be used. In more than 2500 consecutive cases I have not failed to effect puncture in a single case. If there is active disease of bone or the overlying soft parts spinal anæsthesia should not be used.

#### SELECTION

In spinal anæsthesia a very small dose of a toxic drug is used and it is confined to a small area in its direct action. The action is temporary and there is no deleterious effect on structures remote from the area of injection. These points in addition to its particular physiological action peculiarly adapt it to use in certain conditions in which inhalation anæsthesia is contraindicated. The latter is dangerous in these conditions because it places the organism in a state of general toxicity because of its irritative action on the lungs and because of other less important physiological action peculiar to it. In a general way we consider that all operations below the level of the nipples can be done with a sufficient degree of success under spinal anæsthesia to warrant its use in this *selective field* but only in the hands of one with reasonable skill in the method. Facts bearing on physiological action should be the basis for selection in the majority of cases.

Patients in which there is a very high blood pressure, or in which a slight rise in blood pressure would be dangerous, or in which it would be advantageous to lower the blood pressure during operation, should be operated under spinal anæsthesia. The majority of patients in this class would probably be those suffering from advanced arteriosclerosis or cardiorenal disease and aneurisms.

There is less impairment of renal function following operation under spinal anæsthesia than with inhalation anæsthesia. This fact has been definitely determined by a comparative study with the phenolphthalein functional renal test and by careful examination of catheterized specimens of urine before and after operation. This fact renders spinal anæsthesia doubly indicated in the presence of nephritis. Although on two occasions we have seen severe acute nephritis develop after a small operation under spinal anæsthesia we feel that the sudden renal impairment is due more to trauma and toxic absorption than to any effect of the anæsthetic on the kidneys in the case of spinal anæsthesia. With ether anæsthesia it is more reasonable to admit a direct toxic action on the kidneys. The higher percentage of impairment of excretion as shown by the phthalein test gives reason to this assumption.

In tuberculosis of the lungs, chronic bronchitis and all other diseases of the respiratory tract except those mentioned under contraindications spinal anæsthesia is preferable to inhalation anæsthesia.

Persons suffering from hyperthyroidism can undergo operations on the lower part of body with spinal anæsthesia without danger. The slowing of the pulse seen regularly with atovain may be somewhat protective. Unfortunately operation for goiter is not safe with this method.

In our series of over 7000 cases no so-called status lymphaticus deaths have occurred. Where this complication could be anticipated spinal anæsthesia would probably be preferable.

#### SUMMARY

Spinal anæsthesia is a method requiring special training and experience in order that reasonably good results be obtained and safety secured. This is most important in its selective field where cases presenting grave dangers are being handled.

It has a particular field of operations in which it can be considered the anæsthetic of choice in many respects.

It has a wider field of applicability in which less satisfactory but reasonably good results can be obtained.

Operations on the upper thorax neck and head are beyond the scope of spinal analgesia and it should be attempted in this area only under very exceptional circumstances

There are distinct contra indications to

spinal anaesthesia having their basis mainly in physiological action

It has a selective field of applicability in which it is the least dangerous anaesthetic in certain hazardous cases

## CHOLECYSTECTOMY

By MAJOR G SEELIG M D St. Louis

THE present-day operation of cholecystectomy rests upon a basis so firm and so well established that one hesitates before contributing to this particular chapter of surgery. And yet certain more or less weighty considerations point so definitely to the conclusion that the gall bladder can be removed more satisfactorily and with most safety by enucleating it from the fundus downward that there is at least warrant in emphasizing anew this procedure. In pointing out the advantages of this method as contrasted with the so-called typical cholecystectomy (i.e. primary division of the cystic duct and cystic artery and removal of the gall bladder from below upward) there is no thought of proselyting. The winning of surgical converts is a treacherously unsatisfactory procedure. Surgery will always represent highly individualistic effort, and those whose results warrant adherence to a satisfactory method should persist in the practice of that method. The operation of cholecystectomy however has furnished me so much chagrin and so many pitfalls of disaster that it became absolutely necessary to institute a personal survey.

In speaking of pitfalls and chagrin I have in mind chiefly two factors namely death following cholecystectomy in cases where a fatality was not, and in reality should not, have been anticipated and secondly injury to the duct system in spite of the practice of what seemed to be diligent caution. Both of these factors rested wholly or in large part, upon poor technique of that I was certain. I was equally certain that as my operative experience developed and furnished

me in general with commensurate surgical poise and assurance, it was failing markedly to render me this same service in the field of gall bladder surgery. What I was uncertain about was where the fault in technique lay. A clue was furnished by the fact that ten or twelve years ago when I was removing the gall bladder from the fundus downward, I seemed to have had fewer difficulties and certainly fewer qualms than I had after modifying my technique along so-called standard lines by attacking the cystic duct first. Another clue was furnished by the fact that the chapter on postoperative repair of the bile-ducts seems to be much larger in the literature of America than in that of Germany and France, where the operation of choice is removal of the gall bladder from the fundus downward. Evidently the ducts were more frequently injured in this country.

At this stage of the inquiry it became necessary to look into the reasons governing the majority of American surgeons in their choice of the operation from below upward and also to try to establish the fundamental surgical principles underlying the technique of cholecystectomy.

Up to 1900 the operation seems to have been done exclusively from fundus downward. In 1902 W J Mayo recommended this procedure and in 1903 Moynihan described the same technique. Up to 1906 all the standard American textbooks described only this type of operation. In 1906 Erdman describes the same operation but adds that in some cases owing to disagreeable bleeding it is wiser to divide the cystic duct first and remove the gall bladder from below upward. At about

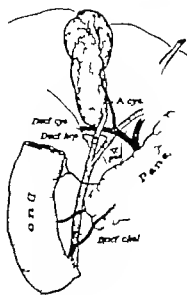


Fig. 2

Fig. 2. The so-called normal relationship of cystic to common hepatic duct, which in reality prevails in approximately 33½ per cent of the cases.

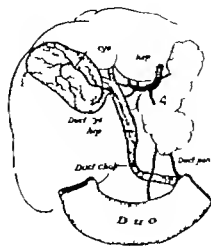


Fig. 3

ducts. This occurs in approximately 5 per cent of cases.

Fig. 3. Another type of parallelism with an accessory cystic duct.

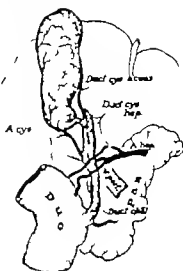


Fig. 4

this same time the Mayos and Moynihan began to advocate the operation from below upward and largely due to their advocacy this type of operation gained favor until now it may be fairly regarded as the typical cholecystectomy in America. This change of front in operative technique seems to rest almost solely on the notion of lessening bleeding. Moynihan adds the laconic argument that by this method the only difficult part of the operation is accomplished first, and the Mayos point out that by this method one avoids injury to the common duct by not having any traction on it.

Aside from the general principles underlying the avoidance of contamination by proper isolation of the intraperitoneal field of operation the approach through adhesions without injury to adjacent structures and adequate properly placed drainage there are three definite principles underlying the operation of cholecystectomy.

1. The operation must be planned so that bleeding becomes as insignificant a factor as possible.

2. The cystic duct must be isolated before it is divided.

3. The common and hepatic ducts must be probed for the presence of stones or constrictions.

**Hæmorrhage.** It is undoubtedly true that hæmorrhage is best controlled at its source by ligating the cystic artery just as it approaches the cystic duct. Most of the recent articles mention the necessity of doing this arguing that if the cholecystectomy be done from above downward the operator is confused by a bloody field. In the performance of cholecystectomy three types of hæmorrhage are apt to be encountered: (1) parenchymatous bleeding from the bed of the gall bladder; (2) arterial hæmorrhage from branches of the cystic artery distributed on the wall of the gall bladder; (3) more serious hæmorrhage from the cystic artery itself near its origin. Both the importance and the consequences of parenchymatous bleeding have been exaggerated. It is almost invariably controlled by a small gauze pack laid against the bleeding area, and very frequently it is possible by careful procedure to strike an almost bloodless plane of cleavage between the gall bladder and under surface of the liver. Arterial hæmorrhage from

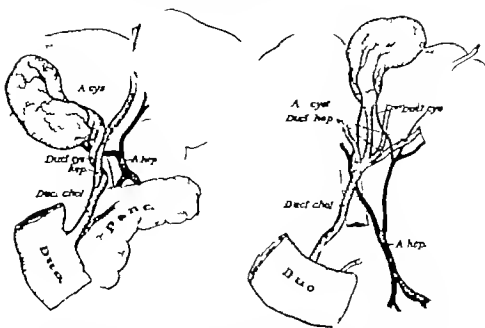


Fig. 4 (at left) Spiral arrangement of cystic duct. This type occurred in some what more than 33% per cent of the cases examined by Ruge.

Fig. 5 An instance of three hepatic ducts an anomaly occurring somewhat oftener than 50 per cent in Ruge's cases.

branches of the cystic artery can always be immediately controlled with artery forceps and offers no greater disadvantage than bleeding from small vessels in the course of any other operation. Indeed very often this type of hemorrhage is an unmixed advantage in that it aids the operator in tracing down the main branch of the cystic artery enabling him with a few strokes of the knife to strip the vessel downward and ligate it near its origin. This method of following the gall bladder downward until one reaches the cystic artery is in many respects analogous to the operation of the thyroidectomy in which by careful step-by-step dissection the lobe of the thyroid is freed until its vessels of supply are brought into view.

The region of the neck of the gall bladder is quite vascular and not infrequently an attempt to expose the cystic artery at this site even by blunt dissection results in the tearing of small subperitoneal vessels. This in turn is followed by rapid subperitoneal blood extravasation which conceals the underlying structures and renders search for them treacherous. This unfortunate subperitoneal ooze is undoubtedly responsible for many instances of duct injury.

As a matter of fact, if one may judge from

his experience in witnessing other men work, the average operator does not ligate the cystic artery separately but grasps in his clamp the cystic artery and the cystic duct together. There is no need to emphasize here that the removal of this clamp after supposed ligation of duct and artery is quite frequently followed by a hemorrhage that is usually perplexing and sometimes difficult to control even if one follows Mayo's advice of carefully exposing the triangle of Calot. If on the other hand in removing the gall bladder from above downward one should encounter exactly the same type of hemorrhage he will find that by using the mobilized gall bladder as a tractor he can aid himself immeasurably in exposing the field and grasping the bleeding vessel without any undue danger of injuring the ducts. We see therefore that parenchymatous bleeding and bleeding from the smaller branches of the cystic artery are in themselves relatively insignificant. If we are to develop a surgical principle regarding hemorrhage it will have to be one governing bleeding from the cystic artery itself. It certainly is not irrational to base this principle on the fact that the cystic artery is ligated more readily and with greater safety after the gall bladder has been mobilized.



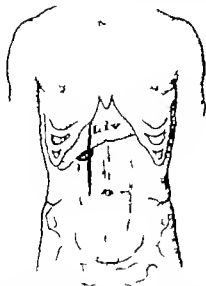


Fig. 6 Incision ordinarily used for operations upon the gall-bladder and ducts.

The second principle to be developed is the one governing ligation of the cystic duct. Shall ligation be performed as a preliminary procedure or after the gall bladder has been dissected downward so as to develop the cystic duct as a pedicle. In speaking of hemorrhage and the best means to combat it, one hesitates to dogmatize, for the simple reason that the occurrence of hemorrhage is dependent in no small measure upon the essential cleverness and genius of the operator. In considering the approach to the cystic duct, however we are on much more solid ground for the reason that we are obliged surgically to reckon with concrete anatomical facts.

The anatomical researches of Ruge, Rio Branco, Kehr, Delbet, and Belou do not seem to have won in America the recognition that they merit. The conclusions reached by these various investigators are in practical agreement. For our purposes the most significant fact developed by them is that the anatomic relationships of the cystic and hepatic ducts is perplexingly variable. According to Ruge the so-called normal or typical arrangement whereby the cystic enters the hepatic at an acute angle, forming a triangle whose base is the cystic artery (the angle of Calot) maintains in only about 33%

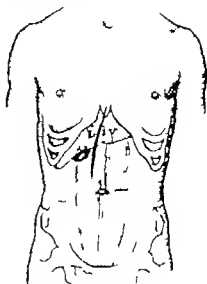


Fig. 7 Incision which furnishes much better exposure.

per cent of cases. In approximately 25 per cent the cystic duct runs directly parallel and in contact with the hepatic duct in most of these instances of parallelism the two ducts are so firmly bound together by connective-tissue adhesions as to defy blunt separation creating the impression that the two ducts are really one. In somewhat more than 33% per cent of instances the cystic is adherent to the hepatic and instead of opening into its right lateral aspect, winds under it, opening into the posterior aspect, or forms a more complete spiral and opens on the left lateral margin or even winds completely around it, and opens on the anterior aspect of the hepatic. In 20 per cent of instances there were three hepatic duct branches instead of two and in 4.5 per cent there were five hepatic duct branches. A mere statement of these anatomic anomalies is not very impressive, but a glance at a schematic representation of them (taken from Ruge's paper) serves most admirably to emphasize the difficulty and danger attendant upon the so-called preliminary ligation of the cystic duct (see Figs. 1 to 5).

The point is simply this. The cystic duct is with greatest safety identified as a structure running from gall bladder to the common hepatic duct. Attempts to pick it up in the

*M rectus ab*

Fig 8 Exposure secured by using ordinary incision pictured in Fig 6

*M rectus ab*

Fig 9 Exposure secured by using incision pictured in Fig 7

region of the gastrohepatic omentum are frequently obscured by the same confusing hemorrhage that we have already described. Even if the field be clear and the duct recognized it ought not to be divided until it is traced back to gall bladder neck and forward to common hepatic duct. Such a dissection may be uncomfortably difficult. If on the other hand the gall bladder is mobilized from above downward the cystic duct comes into view if not automatically at least very readily and once in view is easily developed and freed along its whole course by exerting a little traction on the gall bladder. I have encountered some difficulty in freeing the duct at the point where it emerges from the gall bladder but I am confident that this difficulty is always due to my own inexperience. I have never experienced the slightest

fear of pulling the common duct up and clamping it.

Finally we come to the third principle namely *ascertaining* by means of a probe *whether or not the common and hepatic ducts are unobstructed* throughout their course. In most of the articles devoted to cholecystectomy the authors specifically state that after the gall bladder is removed the ducts should be palpated for the presence of stones. It is of course a well known matter of fact that stones may be present in the duct system without ever producing characteristic symptoms or without producing them until shortly or some time after cholecystostomy or cholecystectomy has been performed. It is an equally well known fact that the location of stones by palpation is a very illusory procedure even when the stones reside in the easily

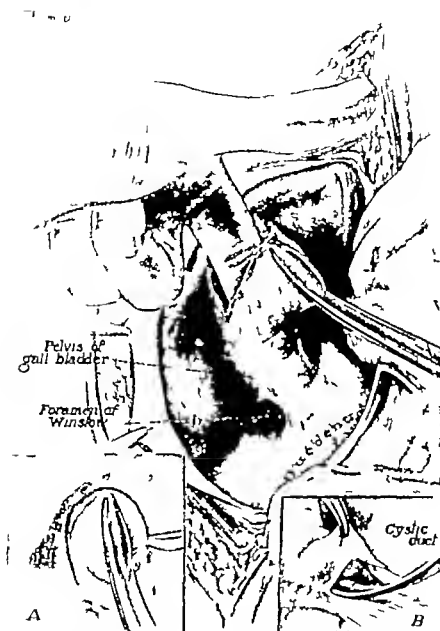


Fig. 6. First step—enucleating gall bladder from box down and to the right, showing separation of fundus from its base. B shows relationship of cystic duct to pelvis of gall bladder.

palpated gall bladder. Much less reliance can be placed on palpating the ducts. Furthermore the ducts are not infrequently partially or completely obstructed by inflammatory or congenital strictures or valve formations, none of which condition can be determined by palpation.

If palpation be supplemented by exploration

of the lumen of the right and left hepatic, common hepatic and common ducts there will be much less likelihood of overlooking stones. It is about as rational not to explore the duct system adequately when operating for biliary disease as it would be to remove a chronically involved appendix without thorough intra abdominal exploration in a case

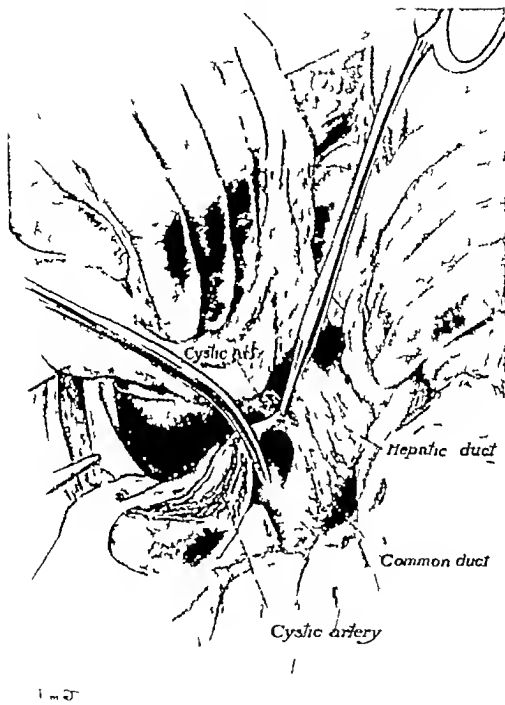


Fig. 11 Gall-bladder completely free Cystic artery ligated Clamp applied on cystic duct distally and artery l ligated proximally to steady stump for probing

of obscure abdominal disease. Probing of the ducts is easily accomplished provided the cystic duct is divided not farther than one half inch away from its entrance into the hepatic. An ordinary copper probe easily finds its way through the cystic stump, common duct, and papilla of Vater into the duodenum or through the cystic stump and common hepatic up into either right or left hepatic.

If the cystic stump is left too long the probe encounters the spiral valves of Heister which blocks its passage through the duct. This probably accounts for the fact that so few operators probe the ducts.

The important conclusion is that a guiding principle in cholecystectomy ought to be thorough exploration of the ducts with a probe. Such an exploration cannot be made

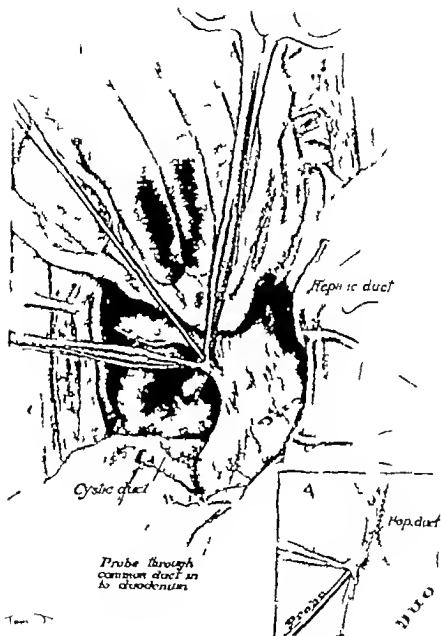


Fig. Illustrating method of probing through papilla of Vater and into the hepatic ducts.

if the popular operation of the day is performed. In this operation the cystic duct, or as I have more usually seen it performed the cystic duct and cystic artery are clamped together doubly divided between the clamps and then the gall bladder removed from below upward. After the duct has once been crushed in a clamp or ligature it is almost im-

possible to find its lumen in order to gain entrance for probing. If the clamp or ligature contains both cystic duct and cystic artery it would of course be hazardous to release these structures in order to attempt exploration of the duct lumen. If on the other hand the cystic duct is exposed from above one may very readily clamp across it at the

proper level divide the duct below this clamp and clearly expose the lumen of the stump by grasping its wall with two or three artery forceps

Bearing in mind the principles already outlined the operation of cholecystectomy is performed as follows. An incision varying in length to meet conditions is placed so that its upper end starts at the tip of the xiphoid cartilage and its lower end is from one to two finger breadths to the right of the mid line.<sup>1</sup> The anterior sheath of the rectus is opened along the whole length of the incision and the belly of the rectus retracted outward. The peritoneum is then opened and if the ligamentum teres of the liver crosses the field it is doubly ligated and divided between the ligatures. This incision has two advantages: it leaves the nerve supply of the rectus intact, and it brings one almost immediately into contact with the gastrohepatic ligament. It is difficult to understand why this incision furnishes a so much more adequate exposure than does the ordinary right rectus incision. The fact of the matter is that the difference is most striking. Figures made directly from the cadaver illustrate the point admirably (see Figs 6, 7, 8 and 9).

After the peritoneal cavity has been opened and the necessary exploration completed all adhesions are separated preferably by sharp dissection, until the gall bladder is in full view and the free edge of the gastrohepatic ligament clearly outlined. Protective packs are then placed special care being used to see that the right kidney pouch and the foramen of Winslow are coffer dammed against the entrance of escaping bile.

The fundus of the gall bladder is now grasped in a clamp and as it is thus held tense light strokes of a sharp knife encircle it a few millimeters from liver substance. These incisions should extend only through the serosa. Frequently a little traction on the gall bladder suffices to strip it from the liver bed; often this stripping process is favored by dividing the serosa along the

lateral margins of the gall bladder. Frequently the gall bladder does not yield so readily when it becomes necessary to separate it from the liver substance by blunt dissection with the finger (Fig 10). Some parenchymatous bleeding always accompanies this step but it is a type of bleeding that is invariably checked by placing a small gauze pack against the bleeding surface. If a spurting branch of the cystic artery is encountered it is immediately clamped. Even if this spurting hemorrhage does not locate the cystic artery for the operator it is usually very easy to detect the vessel on the inner (mesial) aspect of the gall bladder. Once located the vessel is dissected out of its bed and freed to a point median to the cystic duct where it is ligated.

In stripping the gall bladder down one frequently experiences difficulty owing to a well-developed pelvis that conceals the cystic duct in its upper part. In such cases the pelvis is grasped in a clamp and raised from the underlying cystic by blunt dissection (see insert figure). By putting gentle traction on the gall bladder the cystic duct is easily outlined and can be followed down to its end point. This can usually be done by blunt dissection. Frequently a combination of blunt and sharp dissection is necessary.

After the cystic duct is exposed throughout its length, it is clamped across above the point selected for division and held by small artery forceps below this point (see Fig 11). The duct is then divided below the clamp and the gall bladder disposed of. The stump of the cystic is now steadied by means of the artery forceps already attached to it, so that two or three other forceps may be used to grasp the edge of the lumen and hold it open for purposes of probing (see Fig 12). An ordinary probe is now inserted into the lumen of the cystic stump and directed first downward until it enters the duodenum and then withdrawn and directed upward until it enters the common hepatic from which it is directed into the right and left hepatic ducts (see insert, Fig 12). Ordinarily no difficulty is encountered in exploring the lumen of the various ducts provided the cystic duct is not

The transverse incision recently so ably advocated by Moschowitz, gives an equally adequate exposure, but it will doubtlessly take some time before surgeons develop the equality necessary for complete division of orifice across its fibers.

divided at too great a distance from its entrance into the hepatic

After the ducts have been satisfactorily explored the cystic stump is ligated with No 1 chromicized catgut and a rubber dam drain is so placed that the end of the drain lies at the opening of the foramen of Winslow. The stump of the cystic duct lies on the

upper surface of the drain which as it is led out of the abdomen is made to cover the raw bed from which the gall bladder has been removed.

NOTE.—Through the much appreciated courtesy of the Department of Anatomy of the University of Illinois there was placed at my disposal both anatomical material and the valuable services of the artist M. Tom Jones.

## BENIGN TUMORS OF THE INTESTINES WITH SPECIAL REFERENCE TO FIBROMA

### REPORT OF A CASE

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INTESTINAL tumors are rather uncommon, benign tumors of the bowel are still more uncommon, and fibromata are very rare. Thus Heurtaux (1) in a very comprehensive review of the literature up to the date of publication of his paper (1899) could find only three cases of fibroma which had been authenticated by histological examination. Von Bruns (2) says: "Pure fibromata are very rare; fibromyomata are more frequent." Heurtaux could find only three cases that had been examined histologically. Heisig in 1897 operated on a case of fibroma of the small intestine and could find no others in the literature. Galliard and Hutinel (3) make the same observation. They refer to Heurtaux's three cases and also mention one by Schwartz of fibroma of the ileum but do not give the bibliographic reference. In fact medical literature contains but few references to benign intestinal neoplasms and most of the articles are mere case reports. The various textbooks on pathology and on surgery mention the subject casually or not at all. Even works on tumors such as Bland-Sutton (4) and Hertzer (5) dismiss the subject in a few words. We could find only one thorough review of the subject, namely the series of articles by Heurtaux (1) and we feel that we can do no better than to follow the general outlines of the treatise as he leaves little or

nothing to be said in the way of general consideration of the subject.

The basis of Heurtaux's work is a previous paper by Steiner on myomata of the gastrointestinal tract. Heurtaux discards all of Steiner's cases except those of intestinal tumors which have been studied histologically 29 in number. To these he adds 3 myomata. In addition he tabulates all other authentic benign tumors found by him in the literature. He seems to have been influenced in his selection by Longuet (6) thus Longuet accepts some of the tumors reported by Tédénat (7) but for no apparent reason rejects others, although Tédénat's cases with the exception of one were studied histologically. We have therefore included these cases in the tables taken from Heurtaux and added to by us. In addition to a thorough review of the literature I have searched through the records of the Charity Hospital (where about 10,000 operations per year are performed) for many years back but have found no similar case. Case 9 of the table was a tumor of the mesentery but it was included because of the intestinal involvement present.

With the kind permission of Drs. W. J. Mayo and H. S. Plummer I am also able to report briefly several unpublished cases of benign intestinal neoplasms which have come

Under Myomata des Mesenteria, Beitr. Klin. Chir. 1905



Fig. 1. Fibromatoma. a Low power showing mucosa b high power

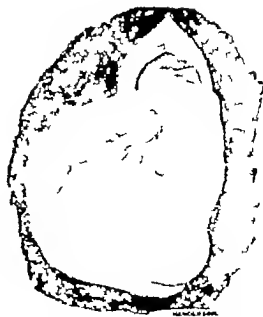


Fig. 2. Fibroma of jejunum Case 14.

to operation in the Mayo Clinic. The annual reports of the clinic were examined with the exception of the report for 1894 which was missing and the records of the cases found were reviewed. Thus out of a total of 44 654 intrapentoneal operations there were found the following

Lipoma of colon	6
Fibromyoma of mesentery	1
Fibroma of mesosigmoid	1
Dermoid cyst of mesentery	1
Myoma of jejunum	1
Fibroma of colon	1
Retroperitoneal lipoma	1
Polyps of colon	1
Papillomata of colon	1

Of these it can be seen that the true solitary intestinal tumors are the 6 lipomata the myoma of the jejunum and the fibroma of the colon. As noted under the heading of adenoma (q r) rectal polypi (which are adenomatous) are fairly common and there were 76 cases noted in the reports as well as

7 cases of rectal papilloma. One case of pedunculated fibroma of the rectum was also discovered. A case of dermoid of the rectum was recorded in the 1909 report but upon referring to the history this was found to be a sacral and not a rectal tumor. The 9 cases from this clinic are considered under the various headings.

Heurtaux states that benign tumors may arise from (a) the mucosa adenoma (b) the submucosa fibroma (c) the muscularis myoma (d) the fat cells of the external coat lipoma (e) the fibrous tissue of the subserosa fibroma (f) epiploic appendages lipoma (g) the vessels of the intestinal wall angioma (h) possibly from muscularis mucosa myoma. He thinks this last source of origin is doubtful due to the poor development of the layer and further states that theoretically tumors may spring from other tissues of the intestinal wall but that such tumors have not as yet been reported. Two cases of teratoblastoma have also been reported (Longuet) both being rectal tumors. The fibrous tissue of the nerve sheath constitutes a probable point of origin as Lenche (9) Branca (10) and Marie and Couvelaire (11) report cases of generalized neurofibromatosis with many intestinal tumors which without doubt are histologically identical with the cutaneous neurofibromata in these



patients. However this has not been proved hence we can only consider them as multiple fibromata very probably neurofibromata. As these tumors are manifestly different from the solitary fibromata we have tabulated them separately in order to avoid confusion.

Heurtaux was able to collect 50 authenticated tumors classified as follows:

Fibroma	3
Adenoma	4
Myoma	3
Lipoma	8
Angioma	$\frac{1}{30}$

In addition to these cases taken from Heurtaux we have collected from the literature 11 fibromata (including our own case) 13 adenomata 13 myomata 21 lipomata 3 fibromyxomata, 3 neurofibromata 1 rhabdomyoma (malignant?) 2 teratoblastomata and 1 fibro-adenoma making a total of 110. We have also investigated many other cases reported or referred to in the literature which we do not consider sufficiently substantiated to be included. These cases will be referred to under the various headings.

#### FIBROMATA

As above noted fibromata are very rare in fact, Longuet doubted their existence. They may of course arise from any one of the several layers in which fibrous tissue is found more frequently however they spring from the submucosa or the subserosa. Vaccari (12) thinks that the tumor in the case reported by him arose from the fibrils lying between the fibers of the muscularis. In our case we are of the opinion that the tumor sprang from the submucosa, as it extended to the mucosa (see Fig. 1 a) which is intact. Thus the intestine was necessarily opened during its removal. As regards location fibromata are about equally distributed between the large intestine and the small thus of the 14 cases reported 5 are of the large intestine 7 of the small 1 of the mesentery and 1 of the ileocecal angle. In size, they vary from a small nut to a five kilogram tumor the size of an adult's head. As to mode of origin we find 6 pedunculated 7 sessile and 1 of the mesentery. Four of the pedunculated

tumors are of the large intestine 2 developing into the lumen of the bowel and 1 into the pelvis. Ten of the cases are females, ranging in age from 23 to 44 years 3 are males, age 17 42 and 50 and in 1 the age and sex are not stated. Three of these tumors were found at autopsy one (Lange) died after operation and the others were cured by operation. We have investigated several other cases reported but do not consider them as undoubted cases of fibroma. Thus Lackmann (13) refers to a report of Grossman who holds the tumor to be a large omental fibroma. Lackmann however thinks this is really a tumor springing primarily from the wall of the transverse colon and secondarily dissecting its way into the great omentum. The tumor was found at autopsy in a patient dying of peritonitis after a year's illness the exact diagnosis not given. A large tumor was found in the omentum and it was also connected with the transverse colon. Histologically it was a coarse threaded fibroma. Obviously we cannot include this tumor in our list. Verneuil (14) reports a case of pedunculated fibroma of the rectum but there is no record of a histological examination of this tumor. In the discussion of this paper Houel stated that he had assisted Velpeau fifteen years before in the removal of a fairly large fibroma of the rectum in which case Follin made a microscopical diagnosis of fibroma. Malassez stated that he had had a case similar to the one reported by Verneuil which was microscopically a fibromyxoma. Selby (15) reports a case of a pedunculated intra intestinal tumor of the ileum which was a fibroma or a fibromyxoma but there is no record of histological examination. Lange (16) refers to a case by Peek<sup>2</sup> but the reference is not sufficiently specific so I am informed by the librarian of the Surgeon General's Library. Thus we have left 14 proved cases of fibroma, and will give a brief résumé of these cases.

**CASE.** Janzen reported by Heurtaux ( ) Female 35 years old ill with obscure digestive troubles, extreme anemia and cachexia. Tumor in

<sup>1</sup>Ueber primäre Tumoren von Peritoneum, Netz, und Mesenterium und seiner cases. Fall, ein primäres Fibrom der grossen Netzes. Inaugural Dissertation, Halle 80.

<sup>2</sup>Krause Fibrom der Dünndarm, 1904.

the left side of the abdomen as large as the fist. At operation, the tumor was found to spring from the colour sessile 13 centimeters of the colon was resected with the tumor. Recovery. Histologically the tumor was found to be a fibroma springing from the cellular connective tissue of the submucosa.

CASE 2 Reported by Heurtaux (1) Female age 32 tenesmus, bloody and frequent stools. Tumor protruding through anus. Operation ligation of pedicle and removal. Histological examination showed it to be a pure fibroma with some irritative and vascular change. Cured.

CASE 3 Reported by Heurtaux (1) Female age 44 tumor first noticed 15 years before operation, during first labor. Since then the tumor protruded from anus at each stool. Obstinate constipation a stool every 8 or 10 days only when preceded by an enema. Pedunculated. Operation ligation of vessels and section of pedicle by the thermocautery. Tumor was the size of an egg weight 41 grams 50 centigrams. Histologically it was a pure fibroma, composed of fine fibrils with some inflammatory changes, no evidence of malignancy was found. Cured.

CASE 4 Reported by Faure and Deplas (17) Female age 23. Diagnosis by family physician, myofibroma of uterus. Myomectomy advised. Upon examination a tumor was found in the median line, extending into both iliac fossae and rising five finger breadths above the symphysis. The tumor was hard painless, and immovable there was no ascites or evidence of collateral circulation. On vaginal examination, the cervix was found to be hard, slightly movable and pushed forward. The fundus uteri could not be outlined and the organ seemed to be continuous with the tumor. The entire pelvis was filled with this hard, smooth regular mass, and manipulating the mass moved the cervix. At operation a tumor the size of an infant's head was found in the pelvis which was capped by what appeared to be the transverse colon. The tumor was freed and it was then seen that it was capped by the cecum and appendix, that it hung from the cecum that the normal uterus was retroverted behind the tumor the adnexa were free and there was no connection between the tumor and these organs. Operation, resection of 10 centimeters of the small intestine, the cecum and lower colon, with the tumor. Lateral anastomosis. Resection of the thickened and inflamed omentum. Drainage. A hematoma developed in the cul-de-sac of Douglas and was drained. The patient was discharged cured one month after the operation. Pathological report. Tumor 14x11x8 centimeters weight 700 grams. Pure fibrous tissue with no muscle and no trace of sarcoma.

CASE 5 Reported by Duckworth (18) Female, age 43. Treated for some years for hysteria. Ill 14 days, and died with symptoms of pyemia. No symptoms during life referable to the intestinal tumors found at postmortem. Autopsy. Part of ileum greatly distended below this it was contract-

ed. Several whitish firm masses were found under the serous coat. On opening the bowel four tumors were found one the size of a large walnut the others the size of horse beans under the mucous membrane. The largest tumor was moderately elastic, and constricted about its center.

The distended portion of intestine was suddenly limited by a sort of pyloric band of muscular fibers about seven inches below the largest tumor and it seemed certain that this mass had been grasped about its middle by the bowel at the commencement of the contracted portion. Thus a partial obstruction had occurred, leading to extreme dilatation of the bowel above (the part in which the tumors were situated) the formation of a thickened band of muscular fibers at the point of constriction and the subsequent contraction of the gut below. Microscopic examination of one of the small tumors showed it to be composed of pure fibrous tissue. There is no record of histologic examination of the other tumors. The tumors evidently sprang from the submucosa.

CASE 6 Reported by Vaccari (12) Tumor of duodenum found at autopsy. Sex and age of patient not given. A tumor was found about the size of a large nut which protruded into the intestinal lumen with its long axis parallel to that of the intestine. Measured 18 x 16 x 15 millimeters. The mucous membrane showed a few ulcerated areas at the summit of the tumor. On histological examination the tumor was found to be a fibroma, singularly lamellated in structure. It apparently arose from the fine intercellular fibrils of the muscular coat.

CASE 7 Reported by Royster (20) Male, age 43. History of indigestion with occasional vomiting the attacks gradually growing worse. At first they occurred every week or two and later became almost continuous accompanied by severe pains in left iliac region. The patient was habitually constipated the stools containing mucus but no blood. Some loss of weight. Was admitted suffering from intestinal obstruction no stool for four days fecal vomiting, temperature 97.6° pulse 100 slight abdominal distention. A mass as large as the first and fairly movable was found to the inner side of the sigmoid. The descending colon and the sigmoid were dull on percussion. The impaction was relieved by enemata and oil. Then the condition was diagnosed as a tumor of the small intestine probably malignant. At operation, an invagination was found, with a twist of the ileum. Enterotomy was performed and tumor with its pedicle excised. Recovery was uneventful. Histologically the tumor was a pure fibroma. Its size is not given.

CASE 8 Reported by Legue (21) Woman, age 30. Interval appendicectomy two years before. She returned complaining of a large abdominal tumor. Tentative diagnosis ovarian fibroma or fibrosarcoma. At operation the tumor was found in the ileocecal angle. Resection and anastomosis

was done with recovery. The tumor was found to arise from the subperitoneal connective tissue external to the muscularis, and to be entirely covered by peritoneum (weight and measurements not given). Histological examination showed it to be composed entirely of connective tissue in some places were found fibers only, but in the greater part of the tumor connective-tissue cells were numerous in the midst of the fibers. No trace of infection or degeneration. The author calls attention to the relation between the operation and the development of the tumor two years later. (Can the operation be considered as an etiological factor or can this tumor be considered as an organization of a very marked inflammatory reaction following the operation?)

CASE 9. Reported by Lenger (12) Woman, age 34. Ill for four years with obscure abdominal pain, and gradual increase in size of abdomen. Painful urination. Diagnosis before operation was at first uterine fibroid later ovarian cyst. A tumor was found in the pelvis, the size of an adult's head, rounded and hard, which could be raised and separated from the normal uterus beneath. At operation a large grayish tumor was found which was not vascular was fluctuating at its upper pole, and was adherent to the small intestine below. The cystic portion was punctured and one and one half liters of reddish fluid was evacuated. The tumor was removed and about 40 centimeters of the small intestine was resected with it then an end-to-end anastomosis was performed. Recovery. Histologic examination, fibroma of mesentery weight 5 kilograms, with a large pseudocystic cavity at upper pole.

CASE 10. Reported by Lange (16) Male, age 30. Large right inguinal hernia for the past fifteen years. Was admitted to Obukhov Hospital with the usual history of intestinal obstruction which had persisted for five days: no stool during this time, constant abdominal pain history of nausea and vomiting. Was not vomiting when admitted. On examination patient was found to be well developed and stout, temperature normal pulse 90 but irregular chest negative abdomen much distended but not rigid painful on pressure on right side, or gans not palpable. Large right inguinal hernia, in which several hard irregular masses were felt. Diagnosis incarcerated hernia. Operations. Usual hernia incision upon opening sac, the cecum and ascending colon were found to be normal, with no obstruction at the ileocecal valve. The incision was enlarged, and an invagination of the ileum was found 50 centimeters from cecum, which was due to an intra intestinal tumor. This area was resected an entero-enterostomy was performed with a Murphy button, and the wound was closed with drainage. Death occurred seven hours later from intestinal paresis and beginning peritonitis. The tumor was about the size of a walnut, very smooth whitish in color and was attached by a pedicle to the inner surface of the bowel, the line

of attachment being drawn in in the shape of a funnel. Microscopical examination showed it to be a pure fibroma, springing from the submucosa. Its origin was demonstrated by using Wedgert's method of staining the tumor and pedicle staining red, while the mucosa took a yellowish stain.

CASE 11. Reported by Dewes (24) Woman, age 66. Constipation for twelve years, gradually worse the past three years, and very obstinate of late. Occasional vomiting spells, and the abdomen became bloated at times. She developed intestinal obstruction which was relieved by enemata temporarily. In two days the obstruction recurred, followed by death in a few hours. At autopsy the whole intestine was found greatly dilated, especially toward the jejunum the stomach was about normal in size. In the region of the ileocecal valve was found a recent intussusception about two inches long with a round movable body attached to the lower end. On removal and examination, there was found an oval sessile tumor partly covered by mucous membrane about four inches from the ileocecal valve protruding into the lumen of the bowel. It measured 3.5 x 2.5 centimeters. Histological examination showed it to be a fibroma, springing from the submucosa. The author proves that the tumor and not the intussusception was the cause of the symptoms and of the obstruction.

CASE 12. Reported from the Mayo Clinic. Male age 17 years. Tumor noticed for two months in the right iliac fossa. Patient had sustained an injury to this region three weeks before appearance of tumor. No pain or bowel disorders. Laparotomy was performed elsewhere two weeks before admission to the Mayo Clinic, and a tumor, thought to be a sarcoma was found encircling bowel. Nothing further was done. During the operation at the clinic on October 30, 1914, a tumor of the ascending colon was discovered, adherent to the scar of the previous operation. A resection and anastomosis was performed eight inches of the ileum, the cecum, the ascending colon, and one-quarter of the transverse colon being removed. At the end of the operation, a sponge was found in the right iliac fossa, wrapped in omentum, with an abscess pocket near it. The abdomen was drained, and the patient recovered. The pathologist reported the tumor to be a subserous fibroma.

CASE 13. Reported from the Mayo Clinic. Female, age 30 years. For the past year had passed bright blood at times with stools. Neither diarrhoea nor tenesmus. Examination revealed a large polypoid rectal tumor. In addition, the patient suffered from hemorrhoids. At operation the tumor and also the hemorrhoids were removed. The pathologist reported the growth to be a fibroma.

CASE 14. Reported by Miller and King. Colored female, age 38. Was admitted to the gynecological service of Dr. C. Jeff Miller Charity Hospital, on September 28, 1915.

Complaint, tumor in left upper abdomen. History. General health has always been good. Mis-

carnage at three months, at the age of fifteen has not been pregnant since. Menstrual history negative, except that for the past year she has had some pain before and during the period, with a steadily diminishing flow. She has noticed the tumor for about twenty months. It has grown very slowly, has caused no discomfort, and has always been freely movable. One physician made a diagnosis of floating kidney, another of uterine tumor. She has been ill for the past two weeks complaining of backache, fever and general malaise. She consulted a physician who gave her some capsules (probably calomel) following this medication she developed abdominal pains, frequent loose stools, nausea, and pyalism. There was no improvement in her condition.

*Examination on admission.* Colored female somewhat emaciated, temperature 102, pulse 120, respiration 34. General examination negative. The abdomen is relaxed and there is no tenderness or rigidity. Liver and spleen not palpable. Left kidney is palpable but not freely movable, right kidney cannot be felt. To the left of the umbilicus is found a tumor somewhat larger than the fist, uniformly hard and smooth. It can be moved freely in any direction but especially to the right. Manipulation of the tumor gives no pain. The pelvic organs are negative and the tumor is found to have no connection with them.

*Urinalysis.* Catheterized specimens on several occasions show a few hyaline casts and leukocytes, no other abnormalities.

*Blood examination.* September 30, 1915. Total white count 23,600, neutrophils 81 per cent. Widal and cultures negative. October 4, 1915, total white count 17,700, neutrophils 83 per cent. The temperature ranged from 100 to 102 up to the day of operation. Operation, October 5, 1915, by Dr. C. Jeff Miller. An upper left rectus incision about four inches long was made, and all abdominal and pelvic organs found negative except for the tumor in the left hypochondrium. This was drawn into the wound (Fig. 2) and was found to spring from jejunum, being also adherent to the subjacent mesentery. There were some adhesions to other coils of the intestine. When these were freed the tumor was found to be hard, of uniform consistency, ovoid, reddish in color and sessile. The bowel above it was dilated to two or three times the normal size. The tumor was removed and during this removal the intestine was opened and the mesentery wounded. The intestinal wound was closed with Lembert sutures of silk, and the mesentery sutured with catgut. The abdomen was closed in layers, without drainage.

*Postoperative course.* The patient left the table in excellent condition, but through carelessness on the part of the orderlies she sustained a fall from the roller and was nearly pulseless when she reached the ward. However she rallied nicely. The next morning the temperature was 104, but by evening this was normal. The convalescence henceforth

was rapid and uneventful; the wound healed by first intention, she was allowed up on the tenth day and went home the following afternoon.

*Pathological examination.* Unfortunately the gross specimen was not preserved. As above noted the tumor was about the size of the fist, ovoid in shape, firm in consistency, smooth and regular. A small section of intestinal wall with intact mucosa was adherent to one side of the tumor.

*Microscopical examination.* Rush section by Dr. H. Windsor Wade, resident pathologist of the Charity Hospital, showed the tumor to be most probably a fibroma, with a possibility of its being a fibromyoma. More careful study of the fixed tissue showed it to be a pure fibroma. The following is the report of Dr. M. Courlet, pathologist of the hospital and assistant professor of Pathology in Tulane University.

Histopathology of S 15-1055 (see Fig. 1). The tumor is limited on the outer side by the peritoneal coat and on the inner by the mucous membrane. The mucous membrane except for evident pressure upon the glandular elements and a diffuse chronic exudative inflammation shows no change. The tumor proper is composed of dense fibrous tissue which shows here and there small areas of hyaline degeneration. The tissue-cells are well differentiated, approaching very closely to the adult type of white fibrous tissue. The nuclei are small, and elongated, and the stroma well developed. The tumor is well supplied with moderately well formed blood vessels indicating that it was of slow growth. Here and there are found small areas of extravasated blood. These are limited more particularly to the periphery of the growth.

*Diagnosis.* dense fibroma.

Under the heading of fibromata, we might include the fibro-adenomata and the myxofibromata. We found two of the former and three of the latter. Casasco (25) reports a case of a small fibro-adenoma which hung from the ileocecal valve and occluded the orifice of the appendix. The tumor was found at autopsy in a patient dying of peritonitis. Rubil (26), Heisig (27) and Gossage (57) report three cases of myxofibroma of the small intestine. Rubil's patient was a woman age 19. The intestine with the growth was resected and anastomosis performed; the patient died. Heisig's case (referred to by von Bruns, 2) was not a pure fibroma, but was a case of myxofibroma of the jejunum in a man 56 years old. Invagination developed, operation and anastomosis result, cure. Gossage reported a tumor of the ileum found at autopsy; the patient was a man aged 21; death was apparently due to peritonitis.

## FIBRO-ADENOMA CASES

CASE 1. Reported by Casasco Riv ospedal. 1912 II 525 In a patient who died from peritonitis, there was found at autopsy a small submucous tumor pedunculated and hanging from the ileocecal valve occluding the orifice of the appendix. The symptoms presented were those of intestinal obstruction.

CASE 2. Reported by Thompson, J. Anat. & Physiol. 1897 xxxi 392 In a woman age 75 there was found at autopsy pedunculated tumor originating at o near the pylorus, causing invagination of the pylorus and the first part of the duodenum into the second part of the duodenum

## MYOFIBROMA CASES

CASE. Reported by G Rubli Ueber ein Fibromyxom des Darms Wuerzburg 1891 Woman age 19 had a tumor of the small intestine. Operation resection and anastomosis. Death

CASE 2. Reported by Heisig Inaugural Dissertation Greifswald 1897 Man age 56 had a tumor of the small intestine (jejunum). The tumor was sessile in the summit of the intestine was about 20 x 5 centimeters in size and weighed 300 grams. The patient had suffered from abdominal pains, colics, loss of weight and anorexia, and other symptoms indicating the presence of a tumor.

Complication invagination. Operation resection and anastomosis. Cure

CASE 3. Reported by Gossage Westminster Hosp Reports, 1895 ix, 105. Man age 31 had a tumor attached to the intestine, 30 inches above the ileocecal valve. The tumor measured  $2\frac{3}{4} \times 1\frac{1}{4}$  inches. There was intestinal ulceration and dark purulent fluid in the abdomen. The patient had suffered from abdominal pain vomiting headache diarrhoea, tarry stools. Tumor located at autopsy

## MYOMATA

Under this heading we are including the fibromyomata, as the various authors consulted make no attempt to separate the one from the other nor do we consider it essential to do so. As is to be expected these tumors are similar to uterine fibromyomata in that the relative proportions of fibrous and muscular tissue vary greatly thus some are pure myomata, while others are composed almost entirely of fibrous tissue. In addition to the thirty two cases reported by Heurtaux we have collected and tabulated thirteen other cases one each reported by Pantzer (28) Kustner (29) Lauenstein (30) Lexer (31) Vulliet (32) Hirschel (33) Prokopyeff (34) two cases reported by Riedinger (35) three cases reported by Carle (36) and one from the Mayo Clinic. We consider that all these

tumors arose from the muscularis as there is slight possibility of any of them having originated from the muscularis mucosa.

As regards the etiology of these tumors, which is of course obscure, Longuet (6) in comparing the rarity of intestinal fibromyomata with the frequency of similar uterine tumors advances the hypothesis that in the case of the uterus the muscle is the main tissue of the organ and is by nature adapted to excessive development, while the reverse is true of the intestine. Here, the muscular layer is thin and stable and has very little tendency to overdevelop. In considering the structure of these growths, Heurtaux claims that they should be classed as myomata, considering the fibrous tissue (whether present in large or small amount) as merely the framework of the tumor and not as forming a part of it. Longuet (6) notes that while, as a rule muscular and fibrous elements predominate we occasionally find a telangiectatic form (case of Westermarck). These tumors are about equally distributed between the large and the small intestine thus 20 are tumors of the former 22 of the latter 1 of the appendix 1 of the ileocecal angle and in one case the location is not stated. In size they vary from a tumor the size of a small nut to the 12 pound tumor of Senn. Females again predominate, as in this series there are 22 females ranging in age from 15 to 79 years (the majority being from 25 to 35 years old) and eighteen males ranging from 36 to 70 years, with 5 cases whose sex and age are not given. Of these cases 26 were cured 8 died 4 were cases (dying from other causes) in which the tumor was found at autopsy and in 7 the termination is not given by the author. Twenty four of the cures were operative cures and 2 were cured by spontaneous expulsion of the tumor *per anum*. Twenty eight were operated upon, with 24 recoveries 3 deaths and in 1 the outcome was not stated. Five were not operated upon, with 2 cures by spontaneous expulsion and 3 deaths due to the tumor. Four were autopsy cases and the case reports of the other cases are incomplete in this regard. Here, as in our consideration of fibromata, we find that the best hope of cures lies in operation.

As in the case of the fibromata, we have found several cases reported which we felt compelled to exclude for various reasons. Thus Lackmann (13) considers the growth reported by Solin (66) a tumor of the transverse colon. However upon referring to the original paper of Solin we find that the tumor was not primarily intestinal but was a myxoma apparently arising from the omentum with abscess formation and perforation into the transverse colon. Lexer (31) reports two cases taken from Koenig's Lehrbuch II 576 the first was a postprostatic tumor in an adult, the second was a postrectal tumor in a 17 year old girl. Heurtaux listed the second case but not the first for this he must have had a good reason probably omission of microscopical examination, hence we will not include it. Lexer also refers to a case reported by Caro<sup>1</sup> but does not touch upon the question of histological examination. This case is also omitted from Heurtaux's list. Selby (15) reports a case which he states to be either a fibroma or a fibromyoma but makes no mention of histological study. Estes (38) reports a case diagnosed by him and by the pathologist as a fibromyoma we consider this to be merely an enormous hypertrophy of the muscular coat of the bowel. The patient presented a large mass in the sigmoid flexure apparently secondary to tubercular changes in the external layers of the bowel wall. The author describes it as

a tumor resulting from an inflammatory hyperplasia with contraction of the longitudinal muscular and serous layers and thereby causing circumstantial hypertrophy by crowding of muscular elements a chronic tubercular process in the external layers of the intestine as the etiological factor. We consider this tumor to be merely a hyperplasia of the outer coat of the bowel wall and not a true tumor. In this view we are supported by Dr. Couret, who referred us to Adams and McCrae<sup>1</sup>. They call such a condition adaptative hypertrophy. Thus we feel that our opinion as to this case is abundantly substantiated. While considering the myomata, it might be well to refer

to Kelly's (8) case of rhabdomyoma though we feel that this case was most probably a rhabdomyosarcoma of vaginal origin. The patient was a child 13 months old, in whom the tumor was discovered at the age of 9 months. There was little pain and no digestive disturbances. Death resulted from an intercurrent disorder and at autopsy the tumor was found to spring from the omentum and intestines. Microscopical examination by the Committee on Morbid Growths showed it to be a rhabdomyoma.

#### RÉSUMÉ OF MYOMA AND FIBROMYOMA CASES<sup>1</sup>

CASE 1. Reported by Foerster. Virchow's Arch. f. path. Anat. etc., Berl. 1858, xlii 270. Man age 70 had tumor of ileum 6 or 7 lines in diameter not obstructing the intestine but protruding into the peritoneal cavity. Tumor discovered at autopsy the patient dying of pneumonia.

CASE 2. Reported by Virchow. Die Krankhaften Geschwulste xxx vol. III 133. Details not given. A calcified, submucous tumor the size of a cherry stone was found in the duodenum in the transverse portion.

CASE 3. Reported by Boettcher, Arch. f. Heilk. v. Wagner 1870 p 325. Gaz. hebdomadaire d. méd. Par., 1870 p 319. Details not given. Tumor located in ileum invagination.

CASE 4. Reported by Schlatzler. Bayer. aertzt. Cor. Bl. Muenchen 1871 No 12 181. Details not given. Tumor located in ileum invagination.

CASE 5. Reported by Pelizzari. Zentralbl. f. Chir. 1875 p 223. Young girl had a tumor, weighing 500 grams in the ileocecal region. A diagnosis had been made of cyst of the ovary. Cure followed spontaneous expulsion.

CASE 6. Reported by Barthel. J. hebdom. de méd. St. Petersburg 1877 No 36. Zentralbl. f. Chir. 1878 No 5. Man had a tumor as large as a pigeon's egg situated in the ileum 8 centimeters above the valve of Bauhin. Invagination. Death.

CASE 7. Reported by Carlier and Van der Eps. J. de méd. chir., et de Pharm. Brux. 1881 p 140. Woman age 21 had a tumor of the rectum. She suffered from tenesmus hemorrhages and abdominal distention. The tumor protruded at defecation. Operation: ligature of pedicle and removal. Later the ligature detached itself. Cure.

CASE 8. Reported by Wesener. Virchow's Arch. f. path. Anat. etc., Berl. 1883 xciii 377. Man age 55 had a telangiectatic tumor of the duodenum. The tumor was as large as a plum, continuous with

CASE 7 0, 16, 24 and 26 also reported by Longuet (6)  
 CASE 5 6, 24 and 26 also reported by Lackmann (13)  
 CASE 5 22 and 26 also reported by Faure Dupas (7)  
 CASE 7 3, 6, 8, 24 and 26 also reported by Lemer (1)  
 CASES 20 and 30 also reported by Estes (38)  
 CASES 16 9, 24 and 26 also reported by Riedinger (15)  
 The first 31 cases are taken from Heurtaux's report.

another tumor  $7 \times 3\frac{1}{4}$  centimeters, which rested upon the pancreas, compressing the common bile-duct. Died.

CASE 9. Reported by Wesener *ibid.* Patient had tumor of the duodenum as large as an apple.

CASE 10. Reported by Heurtiaux, *Gaz. méd. de Nantes*, 1884 p. 135. Arch. prov. de chir. Par. 1896. Woman age 50 had tumor as large as a small apple at the junction of the ascending colon and the transverse colon. There had been signs of intestinal obstruction twice the first time 12 years ago the second time 3 years ago. Finally intestinal obstruction and spontaneous rupture of the pedicle. The tumor remained encased above the valve of Houston extracted. Cured.

CASE 11. Reported by Tédénat *Montpellier méd.*, 1885. Man, age 46 had two myomata of the rectum. The patient had suffered from rectal hemorrhages, constipation, and colics. One tumor was spontaneously expelled the other removed by crushing the pedicle. Cured.

CASE 12. Reported by Fleisser *Virchow's Arch. for Path. Anat.* etc. Berl. 1885 cl. 496. Man, age 53 had a tumor of the ileum in the vicinity of the ileocecal valve. Invagination. Resection of the intestine by Czerny. Cured.

CASE 13. Reported by Koculig, *Lehrb. d. spec. Chir.* 1885 II 455. Girl, age 7 had a red pedunculated tumor of the posterior wall of the rectum, the size of a pigeon's egg. Operation. Bladder cured.

CASE 14. Reported by Heurtiaux, *Soc. anat. de Nantes*, 1887 Nov. Arch. prov. de chir. 1896. Woman age 37 had a tumor of the rectum. The tumor was glossy ovoid and was inserted at the posterior wall by a pedicle as large as the finger. The tumor was as large as an average sized pear. For three years the patient had suffered from constipation and colicky movements. During the past month the colics persisted almost constantly with bearing-down sensation and a sensation of a foreign body in the rectum, mucous and bloody stools. For five days preceding operation there had been obstruction with violent colics, vomiting abdominal distention. The tumor was drawn down through the anus the pedicle tied in two places and cut between the ligatures. Cured.

CASE 15. Reported by Mercer *Med. Record*, 1888, xxx, 67. Woman, age 34 had a globular pedunculated tumor weighing 475 grams, situated in the ileum. The patient had suffered from digestive troubles and the stools were bloody. Death from hemorrhage.

CASE 16. Reported by Senn, *Zentralbl. f. Chir.* 1891 p. 662. Weekly M. Rev. 189. Mar. 21. Woman age 44, had a tumor of the anterior wall of the rectum. The tumor weighed 15 pounds and protruded into the abdominal cavity. The tumor could be palpated in the lower left portion of the abdomen. It was movable, and there was an accompanying ascites. Diagnosis ovarian cyst. Laparotomy. The rectum was opened posterior

to the bladder the tumor removed, and the intestine sutured. Cured.

CASE 17. Reported by Lockwood, *Brit. M. J.*, 1892 p. 966. Woman, age 3 had a tumor of the ileum 70 centimeters above the cæcum. The tumor was calcified in the center and had a pedicle three-fourths inch in diameter. Complication invagination 14 centimeters in length.

CASE 18. Reported by MacCosh, *Tr. Path. Soc.* 1893 April 6. Man age 34 had a tumor of the posterior wall of the rectum. It was hard to the touch and the mucosa seemed to adhere to it. The patient had had difficult defecation for some years, and the stools were reddish. An iliac colostomy was done followed by the operation of Kraske six weeks later the iliac anus was closed. Cured.

CASE 19. Reported by Lode *Wien. klin. Wchnschr.* 804. Man age 66 had a subserous tumor of the ileum a short distance from the cæcum. For two years, the patient had suffered from sudden vomiting at times. A painful tumor was palpable in the caecal region. Death by suicide.

CASE 20. Reported by Fenger *Chicago Clin. Rev.* 804. Man age 75 had a tumor the size of a large walnut in the region of the ileum. The tumor was covered by serous membrane. The patient had suffered from frequent abdominal pain and for one year there had been attacks of ileus. Laparotomy incision of the intestine, and removal of the tumor suture. Cured.

CASE 21. Reported by Geissler *Deutsche med. Wchnschr.* 804 No. 48. Woman age 23, had a tumor of the jejunum  $3 \times 5$  centimeters jutting into the intestine. For six weeks the patient had suffered from intense vomiting and pain. There was a 5 centimeter invagination. Death.

CASE 22. Reported by Kukula *Wien. klin. Rundschau* 1895 No. 20. Man age 71 had a tumor of the small intestine. The tumor measured  $6 \times 3 \times 5$  centimeters and was implanted on the convexity of the intestine causing strangulations. For 20 years the patient had had a hernia. It increased little by little to the size of a child's head. Signs of strangulation developed. Herniotomy performed but the abdomen was not thoroughly explored. Following the herniotomy there was a retrograd strangulation above the hernia. Laparotomy and resection of 20 centimeters of the intestine with the tumor. Cured.

CASE 23. Reported by Eppinger, *Præparat. d. path. Anat.* 896. Woman, age 20 had a tumor of the appendix as large as a small apple. In addition there was a myoma of the clitoris. The tumor was found by chance at autopsy. Death from typhoid.

CASE 24. Reported by Berg *Zentralbl. f. Gynæk.* 1896 No. 1. Man, age 56 had a tumor in the sacral excavation of the rectum. The tumor was fixed to the ulcerated mucosa. The patient had suffered 8 or 10 years from constipation accompanied by serious hemorrhages. The operation of Kraske was done but as a fistula remained,

a second operation was done which cured the fistula. The patient was cured.

CASE 25 Reported by Albert Wien. *klin. Wchnschr.* 1896 No 26 Woman, age 41 had a tumor of the intestine which could not be definitely located. For six months the patient had suffered from alternating constipation and diarrhoea, but no appreciable tumor could be palpated. Diagnosis chronic stenosis of the intestine. Complications invagination which was found to contain a pedunculated myoma the size of a nut. Laparotomy and resection of the invaginated portion. The outcome not given.

CASE 26 Reported by Westermarck *Zentralbl. f. Gynaek.* 1896 No 1 Scalpel, 1896, May Woman, age 49 had a tumor of the anterior wall of the rectum. The tumor was as large as an adult's head and was fluctuating in consistency. For 18 months the patient had suffered from pains in the abdomen and the sacrum from constipation and urinary disturbances. There had been rectal hemorrhages and a round smooth tumor could be palpated in the hypogastrium to the right. Laparotomy revealed a friable tumor springing from the rectum by a pedicle. Death the fourth day from ileus.

CASE 27 Reported by Caro in *Berl. klin. Wchnschr.* 1896 Man age 51 had a tumor of the jejunum. The tumor was twice the size of a child's head and was adherent to the descending colon, to the sigmoid, and to the ileum. The patient had had intestinal troubles for five months, ileus for four days. Patient admitted in collapse. Operation an artificial anus was made. Death followed in four hours.

CASE 28 Reported by Hollander *Zentralbl. f. Chir.* 1896 p 310 Woman age 79 had a tumor of the colon, as large as a plum. Invagination. Laparotomy enterotomy and removal of the tumor. Cured.

CASE 29 Reported by Pfannenstiel, *Zentralbl. f. Gynaek.* No 26 Woman, age 34 had a tumor as large as a child's head, on the posterior surface of the descending colon another in the pararectal tissue which sprang from the mucosa. The tumors weighed together 4 kilograms. The patient had suffered from weakness, incontinence of urine, and dysuria. Laparotomy and removal of the tumor. Cured.

CASE 30 Reported by Krukenberg *Zentralbl. f. Gynaek.* 1897 p 1515 Woman, age 37 had a tumor of the ascending colon. The tumor was the size of a fist, and was adherent by a surface of 2 x 1.5 centimeters to a dilated portion of the colon. The patient had suffered from sharp pains in the lower abdomen to the right. A tumor hard and movable appeared to be attached to the uterus, but under anesthesia was found not to be so attached. Laparotomy and extirpation. Cured.

CASE 31 Reported by Rom Morgagni 1897 pt. 1 No 3 211 Man, age 56 had a tumor 9 x 6 centimeters which was continuous with a portion

of the intestine and appendix. For 20 years he had had pain in the inguinal region. The tumor extended from the intestine to the testicle and was prolonged into the iliac fossa. The tumor and testicle were removed. Cured.

CASE 32 Reported by Petrow *Ann. d. russ. Chir.* 1898 No 1 Man age 37 had a tumor of the ileum. The tumor was as large as a goose egg and was 227 centimeters from the valve of Bauhin. It was adherent to the true pelvis, and at its center a cavity communicated with the intestinal canal by a channel the thickness of the finger. Complications abscesses of the liver and lungs sepsis. Death at the end of 18 days.

CASE 33 Reported by Pantzer *Am. J. Obst. N. Y.* 1913 Lxviii 955 Woman age 15 had a tumor 10 inches from the caecum, which was sessile on the crest of small intestine. The tumor measured 1 1/4 x 1 1/4 inches. The symptoms were those of obstruction. Complications intussusception in ileum. Three inches of the small intestine were resected. Cured.

CASE 34. Reported by Kustner *Verhandl. d. gynaek. Gesellsch.* 1903 iv 72 Woman, age 53 had a tumor the size of a child's head springing from the muscularis of the sigmoid. No details given.

CASE 35 Reported by Lauenstein *Deutsche Ztschr. f. Chir.* 1906 Lxxv, 267 Woman, age 33 had a pedunculated tumor in the transverse colon, which probably sprang from the submucosa. There had been vague intestinal symptoms with evidences of a tumor to the right of the umbilicus. Eenterotomy with ligation of the pedicle and removal of the tumor. Cured.

CASE 36 Reported by Lexer *Verhandl. d. deutsch. Gesellsch. f. Chir.* 1904, xxxi 440 Man, age 35 had a tumor of the rectal wall posterior to the rectum the mucosa was ulcerated. The patient had been ill for several years there had been tenesmus and rectal bleeding. Operation resection of rectum and tumor and establishment of artificial anus. Cured.

CASE 37 Reported by Vulliet, *Rev. méd. de la Suisse Rom.* Geneva, xxvii, 467 Man had a pedunculated tumor 12 1/4 x 14 x 6.5 to 9 centimeters, springing from pelvic colon. There was a large cyst and several small cysts. For two years there had been an enlargement of the lower abdomen following an injury the pain has become worse of late, with obstinate constipation. Laparotomy and ligation of the pedicle. Cured.

CASE 38 Reported by Riedinger *Zentralbl. f. Gynaek.* 1898 xxii, 921 Woman age 38 had tumor in the lower abdomen, thought to spring from the bony pelvis. The tumor measured 30 x 12 centimeters and arose from the anterior wall of the rectum and lower sigmoid. The symptoms before admission not known on admission, she showed symptoms of ruptured uterus. Complications ruptured uterus fetus free in abdominal cavity. Hysterectomy and removal of tumor. Death from peritonitis.



CASE 39. Reported by Riedinger *ibid.* Woman, age 24 had tumor in the splenic flexure and descend ing colon. The tumor was the size of a man's head  $23 \times 21 \times 15$  centimeters, and weighed 3700 grams. The symptoms were characteristic of tumor. The tumor was removed recovery.

CASE 40. Reported by Hirschel Vurchow Arch. f. path. Anat. etc. Berl. 1904 cxviii, 167. Sex and age not given. A tumor the size of a pigeon's egg, was situated 5 centimeters from the duodenojejunal flexure. It was hat-shaped of fairly firm consistency bluish pedunculated. It had a cavity connecting with the intestinal cavity. The tumor had produced no symptoms and was discovered at autopsy the patient having died of sepsis of an unknown cause. Complications: Meckel's diverticulum 8 centimeters long about 5 centimeters from the ileocecal valve.

CASE 41. Reported by Prokopyeff Kharkov M. J. 1914, xvii, 79. Woman, age 38 had a tumor the size of a mandarin to the right of the uterus. It was hard and freely movable. At operation it was found to be attached to the small intestine. It measured  $7\frac{1}{2} \times 5\frac{1}{2} \times 3$  centimeters and weighed 95 grams. There had been pain in the right lower pelvis with no other complications. The tumor was removed and the patient was cured.

CASE 42. Reported by Carle *ibid.* Man age 3. d Camillo Bozzolo 1904 p. 82. Man age 3 had tumor about twice as large as a uterus at term. It was cystic and attached to the intestine about 50 centimeters from the ligament of Treitz. There had been pain in the region of the liver accompanied by some digestive disturbances. The tumor was removed and intestinal anastomosis performed. Cured.

CASE 43. Reported by Carle *ibid.* Woman age 44. The tumor sprang from the small intestine about 50 centimeters from the ileocecal valve. It was the size of a closed fist and was somewhat irregular and cystic. For 19 years there had been abdominal pains, digestive difficulties, obstinate constipation alternating with diarrhea. For the past year there had been symptoms of a tumor. Parts of the tumor had become sarcomatous. Re moval of tumor and enterorrhaphy. Cured.

CASE 44. Reported by Carle *ibid.* Man 35 had tumor of the rectum. The tumor was as large as an egg and was covered with intact mucosa. There had been difficulty and pain on defecation, with a sensation of foreign body in the rectum. The stools were bloody. The tumor was removed. Cured.

CASE 45. Reported by the Mayo Clinic 19 2 July 27. Man, age 57 had tumor the size of a walnut six inches below the duodenojejunal flexure. The patient presented no symptoms which might be attributed to tumor but did present the usual symptoms of duodenal ulcer. Operation gastro-perforating ulcer of duodenum. Enterostomy and resect on of the jejunum. The patient was cured.

Only a few cases of fairly large single adenomata are reported. Several authors, e.g. Tédenat (7) consider adenomata as being fairly common. He states that the majority of mucous polypi of the rectum are adenomata and that they are especially liable to be found in infants causing free hemorrhages which are usually ascribed to hemorrhoids. This author quotes Bryant<sup>1</sup> who claimed that hemorrhoids are very rare in infants. Bryant also considered adenomata to be rather common quoting 30 cases in his own experience (5 adults 14 boys and 13 girls). In 1 case Bryant found three tumors and Allingham (quoted by Tédenat) reported twelve in 1 case. Tédenat saw Forchier of Lyons operate upon a patient (age not given) in whose intestine over one hundred of these tumors were found. The same author quotes Bokai of Pesth who considered these tumors very rare, having found only 25 cases of polypi in 59 970 children. As histological study of tissues was by no means the routine at that time we should not place too much reliance upon these widely divergent opinions. In a more recent paper Smoler (39) reports 124 cases and in a still more recent article, Soper (40) reports 60 cases of polyposis of the colon adding 1 of his own. This title given to these tumors by Soper is a very good one and will probably cover most of the cases of multiple tumors reported by Smoler and others. An analysis of the 124 cases reported by Smoler reveals the fact that only 32 of these cases were studied histologically and of these 11 could be classed as solitary adenomata 9 as polyposis of the colon (2 also presented polyposis of the small intestine) and 12 as rectal polyp. There is no mention of microscopical examination in the re maining 92 cases of these, 7 were in the duodenum 5 in the jejunum or ileum 14 in the colon and 66 in the rectum. Many of these were autopsy cases and no doubt were really adenomata the rectal cases were practically all multiple polypi. Leichtenstern (47) gives no case reports merely stating that, out of 128 cases of intestinal polyp 75 were in the rectum. Sandberg (48) and Bryant

(49) report papillomatous growths and Hewitt (50) reports 2 cases of fibrous polypi of the small intestine but none of these was studied microscopically except Hewitt's second case which was stated to be decidedly of a fibrous nature. Allingham (51) reports a tumor the size of a foetal bead in the neighborhood of the rectum which histologically was a polypoid growth. Under the heading of adenomata we have included only those cases in which one (or a few) tumors of fair size are found. Thus Case 3 of our table, with sixty or eighty small polypi of the rectum would not be included were it not for the large tumor higher up in the large intestine which produced invagination. Adenomata are usually small (about the size of a nut or smaller) though rarely larger ones are found as Cases 2 and 5 in the table. They are generally sessile at times pedunculated with a short thick pedicle. As a rule they are rather firm and regular. The usual location is the large intestine. This is also true of the polypi as stated by Soper. Of his 61 cases in only 9 was the small intestine involved. Of the 17 cases which we have found in the literature 12 were tumors of the large intestine and 5 of the small intestine. As stated by Tédénat and by Soper these tumors especially the polypi are found frequently in infants though no age is exempt. Invagination and obstruction in the case of the large single tumors is a frequent and serious complication, occurring four times and causing death in Cases 3 and 4. Here again surgical treatment is the method of choice operating before the development of invagination if possible.

(The separation of the large tumors from the small multiple ones is purely arbitrary since the latter are histologically adenomata just as much as the former. This division is made merely for the sake of convenience.)

#### RÉSUMÉ OF ADENOMA CASES<sup>1</sup>

CASE 1. Reported by Pozzi<sup>2</sup> Soc de chir 1884. Woman, age 38 had a sessile tumor as large as an almond. The tumor was situated in the rectum. The patient suffered from hemorrhages, tenesmus and diarrhoea. Removal of the tumor

<sup>1</sup>The first four cases are taken from Hewitt's report.

<sup>2</sup>Tédénat states that Pozzi reported two cases but gives no details.

CASE 2. Trélat Soc de chir 1884 describes a tumor of the rectum the size of a fist. Cured by linear crushing.

CASE 3. Reported by Guillet, Soc. Anat. 1887 p 16. A man age 24 had 60 to 80 tumors of the rectum and another in the cæcum producing invagination. The patient had had several attacks of pain in the right iliac region accompanied by vomiting and constipation. An invagination 50 centimeters in length was found. The tumor was removed, but the invagination persisted. Death.

CASE 4. Reported by Lyot, Soc. anat 1891. Child five months old had a single tumor as large as a half nut, in the ascending colon. The child had suffered from colics and had passed blood. An ileocolic invagination was present. Death.

CASE 5. Reported by Tédénat Montpellier méd. 1885. Woman age 40 had a pedunculated mass on the posterior wall of the rectum 4 to 5 centimeters from the anus. The tumor was bossed reddish, and the size of a large pigeon egg. The patient had had colic and had passed blood. Operation the pedicle was ligated and the tumor removed. Cured.

CASE 6. Reported by Wagner Schmidt's Jahrb. 1890 li 92. In a male, child age 5 pedunculated tumor was found at autopsy in the lower portion of the ileum near the mesentery. Rectal polypi also found. The child had died of miliary tuberculosis and hydrocephalus.

CASE 7. Reported by Lambl, Franz Josef Kinderspital Prag 1860 i 378. In a female child age 2 dying of enterocolitis. There was found at autopsy a mass in the submucosa of the ileum.

CASE 8. Reported by Langhans, Virchow's Arch. i path. Anat. etc. Berl. 1867 xxxviii 559. In a patient who apparently died of tuberculosis there was found at autopsy a broad based tumor 13 by 7 millimeters, in the ileum about 3 feet from the ileocecal valve.

CASE 9. Reported by Korojan, Wien, Klin. Wchnschr. 1899 No 9. Man, age 23 had a pedunculated tumor the size of a nut in the lower ileum, which produced invagination. There was a second tumor 10 centimeters higher up and some smaller ones. The pedunculated tumor was found to be an adenoma. For 22 months, the patient had suffered from abdominal pains and vomiting. A mass was felt in the left lower abdomen. At laparotomy an invagination was found which was reduced. Enterotomy and removal of tumor. Cured.

CASE 10. Reported by Smoler Beltr. z. Klin. Chir 1902 xxxvi 149. Man, age 23 had walnut sized pedunculated tumor in lower ileum. The patient had had colics for a year and a half the pain being located especially in the lower right abdomen. There were frequent attacks accompanied by constipation and weakness. Invagination. Enterotomy and removal of tumor. Cured.

CASE 11. Reported by Whitehead Brit. M. J. 1884, p 410. A patient 21 years of age, had a tumor the size of a hazel nut in the rectum also two

tumors in the sigmoid and descending colon. For ten years there had been rectal hemorrhage. The tumor protruded on defecation. The patient also suffered from anemia. The rectal tumor was removed through the anus. Cured.

CASE 12. Shield, Tr Lond. Path. Soc. 1888, xxxix, 130. Reports the case of an orange-sized pedicled rectal tumor which had been present for eight years. The patient suffered from hemorrhages and rectal stricture also from anemia. The tumor was removed through the anus. Cured (?)

CASE 13. Reported by Vergely Jahresber u. d. Forts d. Chir 1893 Female age 2 had a large pedunculated tumor 8 centimeters from the anus also several polypi. For several years the patient had suffered from severe rectal bleeding and other symptoms of tumor. Anemia was also present. The tumor and polypi were removed by ligation and cauterization of their pedicles. Cured (?)

CASE 14. Reported by De Fontgazon and Aubaret Ibid. Man, age 58 had a pedunculated rectal tumor, the size of an egg. Tumor removed. (Cured ?)

CASE 15. Reported by Smoler Beitr z. klin. Chir., 1902 xxxvi, 164. Woman, age 60, had pedunculated rectal tumor size of an egg. Several rectal polypi removed 4 years before. Recently there had been blood in the stools and protrusion of the tumor through the anus. Operation incision through posterior vaginal wall, separation of recto-vaginal septum, and removal of the tumor. Cured.

CASE 16. Reported by Smoler loc. cit. p. 169. Woman, age 64, had a pedunculated tumor of the rectum, 5 or 6 centimeters from the anus. The patient suffered from diarrhea and difficulty in defecation. The tumor was removed through the anus. Cured.

CASE 17. Reported by De Santil, Tr Path Soc. Lond. 1901, lli 79. Man, age 51 had a mass palpable in left iliac fossa, which was found to be a papillary adenoma of the sigmoid. The patient had suffered pain for 15 months loss of weight, diarrhea, at times blood in the stools, and recently vomiting had set in. Laparotomy and removal of the tumor. Cured (?)

#### LIPOMATA

These tumors are fairly common we found 29 cases in the literature, and many reports of tumors which were apparently lipomata, but had not been examined microscopically. Heurtaux reports 8 cases (the first eight of the table). Hiller (45) reports 1 personal case, and gives the details of 16 cases gathered from the literature. In the cases of Castellan (also reported by Heurtaux) Albrecht, and Link, he states that the diagnosis was confirmed by the microscope. In the other cases, he apparently accepts autopsy find-

ings or the descriptions given by the reporters of the cases as sufficient verification of the nature of the tumor. Ward (46) reports 1 personal case (verified histologically) and also reports 2 cases occurring in the practice of Dr W. G. McDonald of Albany New York. Only one of these latter cases seems to have been studied histologically hence we do not include the other in our list. Ward gives short summaries of 34 cases of intestinal lipoma in only one of which (Fuchs) is there mention of histological examination. Tumors which were clinically lipomata are also reported by Zum Busch (52) Richardson (53) Voss (54) Roy (55) and Turner (56).

In the case of lipomata we naturally find the same symptoms complications etc., which characterize the other benign tumors. These growths are found chiefly in the large intestine, occur most frequently between the ages of 40 and 60 and occur with equal frequency in both sexes. Thus of the 29 cases, 15 were in men 13 in women and in 1 case the sex was not stated. The ages of the patients varied from 32 to 83 years but most of them were between 40 and 60. Eighteen of the tumors were of the large intestine, eight of the small and in three cases the location was not stated. Twenty cases were operated upon, with 14 cures 4 deaths and in 2 the result was not stated. In 6 cases the tumor was expelled spontaneously 5 were cured in the other the result was not stated but we can safely assume a cure. Three were autopsy cases.

#### REPORTS OF LIPOMA CASES

CASE 1. Reported by Castellan. Gaz. hebdomadaire, No 20 187. Man, age 43 had a lobulated tumor 1 x 6 centimeters, with a pedicle 2 to 3 centimeters thick, probably rectal. Patient suffered with tenesmus. Spontaneous expulsion of tumor.

CASE 2. Reported by Aveson. Bull. Soc. anat., 1870 Mar 26. Woman, age 83 had a tumor size of pigeon's egg, weight 20 grams, in rectum. Patient suffered with alternating constipation and diarrhea, and sensation of weight in the rectum. Spontaneous expulsion of tumor.

CASE 3. Reported by Morel. Bull. Soc. anat. 1876. Woman, age 46 suffered especially after meals with pain above pubis, which continued to grow worse. Location of tumor not given. Spontaneous expulsion.

CASE 4. Reported by Voss. Lond. M. Soc., May 1881. Woman, age 47 had tumor size of an

egg nodular with a long pedicle to rectum. Tumor appeared through anus at defecation. Later stools were bloody. Invagination. Operation eouclea-  
tioo by incision of mucosa. Result not given.

CASE 5. Reported by Tuffier. Soc. anat. 1881, Prog. méd. 1882. Woman, age 43 had tumor of left iliac region the size of a large orange. Patient suffered with pain in left iliac region and obstinate constipation for one year with stools every 6 to 10 or even 20 days. Invagination for 12 days. Tumor felt 1 centimeter from anus. Operation lateral laparotomy artificial anus. Death from peritonitis.

CASE 6. Reported by Tédénat. Montpel. méd. 1885. Woman, age 64 had small rectal tumor 13 x 6 millimeters. Patient had bloody stools every 4 days, with weight in rectum. Operation linear crushing. Cured.

CASE 7. Reported by Notan Larrier and Roux. Soc. anat. Par. 1897. May Woman, age unknown had tumor of duodenum 6 x 3 centimeters with small pedicle, 8 centimeters from pylorus. No symptoms. Death from pneumonia the tumor being found at autopsy.

CASE 8. Reported by Heurtiaux. Arch. prov. de Chir. 1900 ix. Woman, age 60 had tumor, 67 x 48 x 40 millimeters in superior part of descending colon. Patient had suffered with colics and pain in left hypochondrium for 8 years, with weight in rectum and side finally complete obstruction. Subacute invagination for 15½ days. Operation pedicle as large as index finger was ligated and cut. Invagination was reduced spontaneously. Cured.

CASE 9. Reported by Tédénat. Montpel. méd. 1885. Man, age 65 had postrectal subserous tumors size of fist (found at autopsy). Suffered with intestinal obstruction at times. Death from strangulated right inguinal hernia and peritonitis. Hernia was probably produced by straining due to obstruction by tumor.

CASE 10. Reported by Tédénat. Ibid. Gaz. hebdom. 1870. Man, age 43 had tumor 12 x 6 centimeters. Patient suffered with obscure digestive disorders infrequent and difficult stools obstruction at times. Finally had a more severe attack and spontaneously expelled the tumor. Cured.

CASE 11. Reported by Langemark. Beitr. z. klin. Chir. xxviii 247. Woman age 57 had tumor size of a walnut near hepatic flexure. Patient suffered with abdominal pain and indefinite intestinal troubles. Chronic ileocecal invagination. Operation resection and anastomosis. Cured.

CASE 12. Reported by Hahan. Muenchen. med. Wehnschr. 1900, ix, 288. Man age 43 had 4 polypi in small intestine. Suffered with intestinal obstruction no stool for 6 days. Invagination. Operation resection of 15 centimeters of the small intestine. Cured.

CASE 13. Reported by Gross. Wein. klin. Wehnschr. 1900 xlvii 160. Man, age 47 had submucous tumor in left half of transverse colon. Suffered with intestinal disturbances and other

symptoms of tumor. Operation enterotomy and removal of tumor. Cured.

CASE 14. Reported by Fuchs. Wein. klin. Wehnschr. 1901 viii 182. Man age 47 had tumor size of walnut in ileum near ileocecal valve. Symptoms were those of chronic ileocecal invagination. Operation enterotomy and removal of tumor. Cured.

CASE 15. Reported by Huss. Hygiea June, 1884. (Quoted by Heisig.) Man age 44 was ill for 3 years, cause not stated. Death from other cause. At autopsy many tumors found in stomach and 12 found in intestine which were pedunculated and submucous. Size varied from a nut to a bean.

CASE 16. Reported by T. Müller. Beitr. z. klin. Chir. 1890, xxiv 500. Man age 51 had lipoma size of walnut of small intestine originating from fat-cells between mucosa and muscularis. Patient suffered with acute colic vomiting rigid abdomen and rapid pulse. Diagnosis high intestinal obstruction. Invagination 50 centimeters long. Operation resection, with cod-to-end anastomosis. Death from peritonitis.

CASE 17. Reported by S. B. Ward. Albany M. Ann. 1904 xxv 14. Man age 37 had lipoma of rectum (?). Suffered with colics slight constipation, abdominal tenderness and occasional vomiting. Spontaneous expulsion of tumor with cure.

CASE 18. Reported by Ward. Ibid. (Case of W. G. McDonald.) Woman age 50 had lipoma of jejunum 2½ x 1¼ inches. Suffered with violent abdominal pain. Loss of weight. Constipation more recently. Operation laparotomy and removal of tumor. Cured.

(Another case of McDonald reported by Ward no histological examination.)

CASE 19. Reported by Albrecht. Petersh. med. Wehnschr. 1880 No 9. Sex of patient not given. Age 51. Had tumor with thin pedicle. Suffered with abdominal pains diarrhoea. Slimy and bloody stools. Spontaneous expulsion. Result not given.

CASE 20. Reported by Link. Wien. klin. Wehnschr. 1890 No 13. Man, age 40 (?) had pedunculated tumor of rectum protruding through anus. Palpation showed abdominal tumor. For 5 years, patient had had attacks of intestinal obstruction and hemorrhages at times. Tenesmus for 3 years. Operation excision per anus. Result not given.

CASE 21. Reported in St. Thomas Hospital Reports, 1899 xxviii 60. Man age 56 had mass in sigmoid region, which on palpation was found to be a pedunculated tumor the size of an orange. Patient suffered with constipation rectal hemorrhages and abdominal pains. No vomiting. Bloody and mucous stools (no fecal matter). Operation sigmoid opened pedicle ligated and tumor removed. Cured.

CASE 22. Reported by Stable. St. Thomas Hospital Reports, 1894 xxiii 115. Man age 33 had a pedunculated tumor which was a submucous

lipoma, about 30 inches from cecum. It was attached opposite mesentery and caused intussusception of 8 feet of bowel. There was acute pain in lower abdomen, vomiting and abdominal rigidity. Operation laparotomy and reduction of intussusception. Tumor removed (?) Nine days after operation sudden rise in temperature and signs of sepsis. Second laparotomy showed a large slough of the bowel. Ten days later secondary hemorrhage and death.

CASE 23. Reported by La Garde. Progress (Louisville) 1886 1, 264. Man age 65 had pear-shaped pedunculated rectal tumor  $3\frac{1}{2} \times 1\frac{1}{4}$  inches. Patient had usual symptoms of rectal tumor for three years. Mucous and bloody stools. Tumor later protruded and could be palpated and seen through speculum. Operation ligation and section of pedicle. Cured.

CASE 24. Reported by Mayo Clinic January 20 1905. Woman, age 61, had large tumor of sigmoid considered to be secondary to chronic inflammation of sigmoid due to fecoliths. Preoperative diagnosis ovarian tumor. Some pain and other symptoms of tumor in pelvis. Operation resection of 8 inches of sigmoid with anastomosis. Cure. Died of another complaint in 1911.

CASE 5. Reported by Mayo Clinic July 3 1906. Woman, age 51 had tumor of sigmoid. Suffered with obstinate constipation and lower abdominal pain for 5 or 6 months. Stricture and diverticulitis. Fistula of cecum. Tuberculous retroperitoneal glands. Hernia following previous operation. Gall-stones. Operation resection of 8 inches of sigmoid. Gland removed. Cecal fistula closed. Hernia repaired. Death 17 days after operation.

CASE 26. Reported by Mayo Clinic June 21 1906. Man age 55 had lipoma of sigmoid, upper portion. Details not given. Operation resection, with end to end anastomosis. Result not given.

CASE 27. Reported by Mayo Clinic, April 1914. Woman, age 28 had degenerating cystic lipoma adherent to small intestine and to sigmoid, also a large irregular pelvic mass. Patient had had subtotal hysterectomy 3 years before at another clinic. Abdominal tumor for three weeks, slowly enlarging. Slight diarrhea. Operation removal of tumor excision of cervix and a portion of the pelvic mass.

CASE 28. Reported by Mayo Clinic September 30, 1914. Man age 56 had submucous pedunculated lipoma size of an egg causing intussusception, which was reduced spontaneously before operation. Patient suffered with alternating constipation and diarrhea for 6 years. Bloody and mucous stools. Pain in left iliac fossa. Operation resection of 10 inches of sigmoid with end to end anastomosis. Cure.

CASE 29. Reported by Mayo Clinic October 2 1915. Woman, age 37 had pedunculated submucous lipoma,  $1 \times 1 \times 5$  centimeters, 3 inches from ileocecal valve. Had suffered with alternat-

ing constipation and diarrhea for 8 years. Bloody and mucous stools. Pain in left iliac fossa. (Previous operation, colotomy and short circuit.) Operation resection of cecum 3 inches of ileum, appendix, ascending hepatic flexure. Anastomosis. Cure.

NOTE.—The first eight cases are taken from Heurtaux's report. Cases 4 and 6 also reported by Longuet (6).

#### ANGIOMATA

Angioma of the bowel is very rare imperfect records of only 3 cases being found. Heurtaux tabulates these cases but Longuet considers Case 1 doubtful. We could find no other cases nor could Dewes (24). Lauenstein (30) however refers to a case of Nicholls but the reference<sup>1</sup> does not give the year of publication.

#### ANGIOMA CASES<sup>2</sup>

CASE. Reported by Marsch,<sup>3</sup> after Longuet. 808. Girl age 0. Tumor located in rectum. Details not given.

CASE 2. Reported by Arthur Barker after Longuet, 808. Man, age 43. Details not given. Death from anemia.

CASE 3. Reported by Pierre Delbet. Leçons de clin. chir. 1899. Woman age 2 had a circumscribed tumor 5 centimeters wide (cavernous angioma) located in small intestines. There was chronic intestinal obstruction but no occlusion. Operation laparotomy. Death.

#### TERATOBLASTOMA

Teratoblastomata of intestinal origin are also very rare. Longuet (6) records two cases both in females and quotes a third case reported by Barker as a rectal tumor but which Longuet considers to be very probably a sacral tumor becoming adherent to the rectal wall secondarily.

#### TERATOBLASTOMA CASES

CASE 1. Reported by Dantzell. Arch. f. klin. Chir. p. 442. Cong. Chi. Berl. 1874 p. 347. Woman, age 25, had submucous tumor size of an egg. Consisted of fibrous tissue with two poorly developed teeth. Details not given.

CASE 2. Reported by H. Post. Tr. Path. Soc., 880. xvi, 307. Woman, age 16 had thickened polypoid tumor a teratoma containing bony tissue, skin, hair muscle fibers, and a canine tooth. The tumor protruded at anus, a mass of hair showing at each stool. Two short pedicles were ligated and removed. Cure.

Nicholls. Brit. M. J. April

This table was taken from Heurtaux

Longuet does not consider this an authentic case.

## NEUROFIBROMATA

Three cases are reported in which many intestinal tumors histologically fibromata were found in cases of generalized neurofibromatosis. There are other cases reported but no histological examination was made. This examination in these 3 cases however showed nothing characteristic of neurofibromata, as no elements of nerve-tissue were found but the most probable assumption is that they were true neurofibromata. They are certainly very different from the large single fibromata as shown in the reported cases. An interesting point is that these tumors are frequently found in tubercular subjects also interesting is the fact that they are frequently found associated with sarcoma (Case 1)

## NEUROFIBROMA CASES

CASE 1. Reported by Leriche, Lyon chir 1911 vi 70. Man age 45 had neurofibroma located in the pylorus also many small tumors of the intestines which were fibromata with no trace of nerve tissue. The pyloric tumor showed early sarcoma. There was pyloric obstruction, and patient also suffered from generalized neurofibromatosis and pulmonary tuberculosis. Operation gastro-enterostomy pylorotomy. Death two weeks later from purulent pleurisy.

CASE 2. Reported by Mane and Couvelaire. Nourveauconog de la salpetriere 1900 xiii 26. Patient had ten tumors in small intestines two in duodenum others in jejunum and ileum. Large intestine free. No symptoms. Generalized neurofibromatosis. Tumor found at autopsy.

CASE 3. Reported by Branca. Bull. Soc. anat. Par 1897 lxxii 166. Patient had many tumors springing from intestines. Details not given. Generalized neurofibromatosis. Tumor found at autopsy the patient dying from pulmonary tuberculosis.

A résumé of these cases brings out these facts one hundred nineteen cases of benign tumors were found divided as follows

Fibroma	14
Adenoma	17
Myoma	45
Lipoma	19
Angioma	3
Teratoma	2
Fibromyoma	3
Neurofibroma	3
Rhabdomyoma (malignant)	1
Fibrosarcoma	2

As regards location they are distributed as follows

Duodenum	5
Jejunum	8
Ileum	23
Small intestine (not designated)	11
Ileocecal region	3
Appendix	1
Colon	22
Rectum	36
Intestine (not designated)	10

As regards the patients we find 46 males ranging in age from 17 to 75 years 61 females whose ages vary from 13 months to 83 years and in 12 cases the sex and age are not stated.

In considering the symptoms Heurtaux divides the cases into three groups first, the small tumors causing no symptoms which are found by chance at operation or autopsy second larger tumors growing toward the serosa and causing little or no symptoms except the pressure of a tumor third tumors causing intestinal disturbances which may be (1) irritative, or (2) partial or complete obstruction. In the second class of cases there may in some instances be an obstruction from adhesions or from the pressure of a large tumor. In the third class the symptoms vary from vague intestinal pains in digestion etc. to colicky attacks vomiting often obstinate constipation, which may alternate with diarrhoea. At times true obstruction develops which may clear up spontaneously may be relieved by purgation and enemata or may require operation. Some cases are characterized by a persistent diarrhoea. At times bloody and mucoid stools are complained of especially in the case of a rectal tumor. These latter are also characterized by tenesmus, a sensation of a foreign body in the rectum and at times the appearance of the tumor at the anus during defecation.

The diagnosis rests on the above symptoms which generally appear as follows (Heurtaux)

1 Rectal tumor which presents at anus or is felt in rectum accompanied by tenesmus bloody stools constipation, and sensation of a foreign body in the rectum

2 Tumor felt on examination with mild indefinite digestive symptoms.

3 More or less grave intestinal disorders such as partial or complete obstruction, etc. no tumor felt (usual)

4. Similar to 3 but tumor is felt (rare)

5 Tumor only no subjective symptoms (rare)

As can be seen from the case reports and from the tables the most frequent complication is invagination, which occurred twelve times in Heurtaux's 50 cases (adenoma, twice myomata, seven times lipomata, three times) and eleven times in the additional cases collected by us. This is a rare occurrence in the case of a malignant tumor of the intestine on account of the different mode of origin and growth of the latter. Another eventuality in the case of pedunculated tumors (of the rectum in particular) is spontaneous rupture of the pedicle and expulsion of the tumor. Heurtaux noted this occurrence six times (myomata, three times, and lipomata, three times).

The prognosis depends chiefly on the location of the tumor and its mode of growth, whether internal or into the lumen of the bowel, or external or toward the serosa. In other words, the prognosis depends on the effect of the tumor on intestinal function. Of course, the size of the tumor and the presence or absence of adhesions are points to be considered. The prognosis is more favorable in the case of rectal tumors than in the abdominal type. Eliminating the cases in which the tumor was found at autopsy (the patient dying from other causes) we find the following: 76 cases were operated upon, with 12 deaths (result not given in 7); 6 cases were not operated upon with 6 deaths, due to the tumor. Thus we see clearly that the operative treatment is the method of choice in dealing with these cases.

In conclusion I desire to express my thanks to Dr. Miller for permission to publish his case, and for his aid in securing references to the literature. I wish also to thank Dr. A. L. Levin, of New Orleans, for translating the articles of Prokopyeff and Lange from the original Russian, and Dr. Peter Graffagnino of this city for assistance in translating one of the Italian articles. Mr. Augustin, the assistant librarian of the local Medical

Society, the librarian of the Surgeon General's office and Dr. Audrey Goss and W. A. Brennan of the John Crerar Library were very courteous and obliging in many ways, and their aid is greatly appreciated. I am also under obligations to Dr. S. D. Henderson who has kindly supplied the illustrations.

NOTE.—After this paper had gone to press, I found the following case of fibroma, which had caused intussusception, being reported under the latter heading, it had not come to our notice in our search of the literature.

Reported by Means and Forman (67). Female, white, age 47. Previous history negative, no intestinal trouble. She had been ill 10 days, beginning with partial obstruction and attacks of colic, then developing into true intestinal obstruction. Leucocytosis was present. At operation a recent intussusception was found, ileocolic, reaching almost to the hepatic flexure, with pedunculated tumor at its tip. Reduction was performed, and tumor was found in the ileum, about 10 inches from the ileocecal valve. The intestine was opened, the pedicle ligated and the tumor removed. The intestine and the abdomen were closed as usual, the patient making an uneventful recovery.

The pathologist reported it to be an edematous fibroma, 3.5 x 4.3 centimeters.

A case reported by James and Sappington (68) under a similar title has also been reported very recently. The patient was a woman age 34 rather underdeveloped. Past history unimportant. She was seized suddenly with intense abdominal pain, felt faint and weak, and was nauseated. The pulse was slow and weak, temperature slightly subnormal, face pallid, abdomen rigid and tender. She reacted somewhat but the tenderness and rigidity persisted. Pelvic and abdominal examinations were negative. A tentative diagnosis of ovarian cyst with twisted pedicle was made. At operation, an intussusception was found, with 55 centimeters of gangrenous, invaginated intestine at its distal end a tumor was felt. Resection and anastomosis were performed the patient's convalescence was fairly smooth. Pathological examination revealed a sessile, submucous tumor, 4.2 x 9.1 centimeters, opposite the mesenteric border. Microscopically it was found to be a hard fibroma originating from the subserous layer.

The authors refer briefly to 24 other intestinal fibromata (most of these being included in our report) but it is necessary to refer to the original papers in order to be certain that a histological examination was made in each case. For example, of the 29 benign intestinal neoplasms collected by Dewes, only a small percentage had been examined microscopically. The additional cases mentioned by James and Sappington will be investigated and reported upon later.

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## FATTY TUMORS OF THE UTERUS

WITH THE REPORT OF A CASE AND NOTES ON CLASSIFICATION

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UTERINE tumors which are characterized by being composed chiefly of fat-containing tissues are very interesting because they are still of uncertain origin. The cells which contain the fat globules have never been certainly identified and for this reason there is a great deal of confusion in the literature regarding the proper name for this type of tumor. These tumors have been called by various authors lipomata, myolipomata and merely fatty tumors. Some have classified them as mixed tumors under the name of lipofibromyomata while others have referred to them simply as a type of degeneration in leiomyomata.

That these tumors occur rarely is evidenced by the fact that there have been collected, in addition to our case only fourteen other unquestioned instances and when we stop to consider the enormous numbers of fibroids which have been removed and sent to laboratories for examination, the relatively small number which have been found to contain fat becomes considerably emphasized.

The cases reported in the literature prior to 1903 were collected by Seydel (1) who accepted up to this time four cases of true lipoma and a total of eleven of what he called lipomatous tumors.

In 1906 Ellis (2) reviewed these reports and added one case of his own, an interstitial fatty tumor 8 x 6.5 centimeters removed at autopsy from a woman aged 60. Microscopically there were seen typical lipomatous cells round or polygonal in shape but much larger than those of normal adipose tissue, with their nuclei flattened and crowded to one side. The capsule consisted of fibrous or fibrofatty tissue with fat cells in it but there was little fibrous tissue in the tumor.

Sitzenfrey in 1910 (3) reported an intramural lipomyosarcoma of the anterior wall of the uterus, about the size of a small child's head containing in its middle a fatty area 9 x 2.5 x 5

centimeters. In addition there were some myomatous nodules present with fatty infiltration and projections into the myomatous tissue. The fatty tissue was arranged as irregular masses as diffuse and infiltrating areas, and showed the usual reaction of fat stains. In the septa and the neighboring tissues were groups of lipoblasts many of which contained small fat droplets the fat droplets were described as gradually passing into large fat cells.

Ley (4) described a tumor of the uterus, 12 centimeters in diameter composed of closely set nodules 1-3 centimeters in diameter some of which had yellow strands running through them. Microscopically there were fatty envelopes filled with fat globules separated by narrow strands of collagen fibers and muscle. Ley considered the tumor a fatty metamorphosis of fibrous stroma rather than a fibromyolipoma. His figures represent the diffuse fat as composing about one half of the total tissues. Ley also referred to a lipoma or fibrolipoma placed in the museum of St. Bartholomew's Hospital by Sir James Paget, but without microscopic sections.

A very brief review of the cases quoted by Ellis seems advisable here. (1) Leberts (5) pictured a lobulated fibrofatty or musculo-fatty tumor unbedded in the uterine wall. (2) Strolinski (6) 1880 reported a lipoma existing as a polyp on the anterior lip of the cervix. (3) Orth (7) 1893 mentioned a lipomatous polyp. (4) Bruennings (8) reported, in 1899 a lipomyoma the size of a child's head in the anterior wall of the uterus of a woman of 55. (5) Franque (9) in 1901 described a lipofibromyomatous cervical polyp the size of a pigeon's egg. (6) Knox (10) in 1901 described, in detail an interstitial lipomyoma of the posterior wall of the uterus removed by hysterectomy from a woman aged 62 which measured 10 x 13 x 10 centimeters. (7 and 8) Meckel (11 and 12) 1901 reported two cases, one of interstitial lipoma the size of a billiard



Fig. 1 Lipoma of the uterus. Cross section through the greatest convexity showing the large fatty mass in the posterior wall. The displaced uterine cavity is seen near the left of the picture.

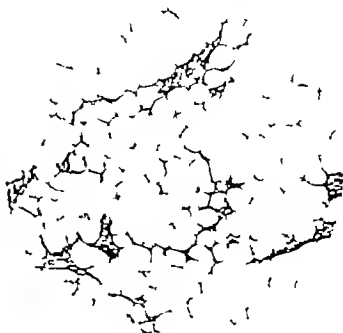


Fig. 2 Microscopic section through fatty portion of tumor

ball the other was a lipofibromyoma the size of an orange in the body of the uterus of a woman of 63 (9) Jacobson (13) 1903 described a lipofibromyoma 8 centimeters in diameter in the anterior wall of the uterus of a woman 68 (10) Seydel (loc. cit.) in 1903 found a walnut size lipofibromyoma in the uterus as an interstitial growth of the fundus uteri in a woman of 58 (11) Meyer (14) in commenting on Seydel's case reports in the same paper a subserous lipoma the size of a cherry stone in the uterine fundus of a woman of 42

Seydel cited three other cases which he did not accept as belonging to this group viz Lobstein (15 cited by Meckel) in 1903 described a fatty tumor of the uterus the size of a 7-8 months pregnancy Seegar in 1853 reported a tumor the size of a child's head which protruded externally and was removed by ligation of the pedicle it was macroscopically a fatty tumor traversed by firm fibrous bands T Smith (16) in 1861 presented a tumor before the Pathological Society of London pedunculated in character the size of two fists and projecting from the fundus it was chiefly of firm fibrous tissue imbedded in it and easily shelled out, was a fatty tumor the size of a pigeon's egg

Several cases reported by the older writers were believed to be instances of fatty degen-

eration of pre-existing tumors usually myomata. Even this change is rare According to McDonald (17) only seven cases reported by various writers in five hundred and thirty cases of uterine fibromyoma, showed this change

With the hope of offering some additional data which will aid in clearing up the question of the origin and proper classification of these tumors we are reporting our studies on a case which occurred on the surgical service of Dr S V King at the Allegheny General Hospital together with our conclusions as to its probable histogenesis

**History** S R colored single age 46 admitted to the Allegheny General Hospital June 30 1914 complaining of vaginal bleeding of four years duration with hemorrhages occurring about once a week. Two years previously she had noticed gradual enlargement of abdomen which she attributed to pregnancy A diagnosis of myoma of the uterus was made and abdominal hysterectomy performed July 3 1914 by Dr King Recovery was uneventful.

**Macroscopic description** The specimen consisted of the uterus amputated at the cervix and contained tumor masses weighing together 4108 grams and measuring 21 x 24 x 15 centimeters. The perimetrium was smooth, except for a few tags of adhesions. The myometrium varied from 1 to 2 centimeters in thickness. The largest part of the specimen was made up of a tumor measuring 16 x 15 centimeters in diameter being practically spherical in shape and occupying all of



Fig 3. Microscopic view showing smooth muscle and connective tissue bundles running through tumor.

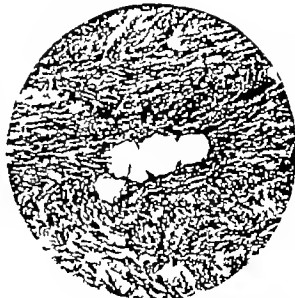


Fig 4. Microscopic section showing giant cells surrounded by smooth muscle and connective tissue masses.

th posterior wall of the uterus. This tumor was well demarcated and entirely encapsulated and was covered by intact endometrium with smooth endometrium. Through this position the posterior wall it produced an enlargement. I marked distortion of shape of the uterus. In the cervical portion of the uterus there was a tumor measuring 5 x 6 cm. It was 1 cm. in diameter. They were separated in position and distally separated from the large tumor. When removed the large tumor was found to be made up of a yellowish white fatty like tissue which was soft in consistency and irregular in brous bands running through it. It was quite greasy on palpation and had a striated appearance usually found in myomata. With proper staining it showed the typical characteristics of fibrous tissue. The irregular strands mentioned above (see illustrations). The smaller tumors were limited in size and firm in consistency and had irregular borders. There were a few small blood vessels running through the tumor masses. The arteries and blood vessels were cut off close to the tumor. There were no evidence of retrograde changes, changes, or cyst formations. On examination the tumor was the peculiar odor of the large tumor mass when it was incised. It was too strong to scent the whole laboratory and was exceedingly aromatic and sweetish. It was like the smell of some what over ripe but not yet rotten apple.

*At grossscopic description.* Sections taken from the various portions of the large tumor mass showed practically the same general characteristics. These consisted of irregular islands of fibrous tissue which were quite large in size and had the usual

flat nuclei some of which were very isolated lying between the fibrous islands and the individual cells were also composed of other types of cells. One of these types was long spindle-shaped cells with oval nuclei. Stained with phosphotungstic acid hematoxylin this type of tissue consisted of the most part of the straight fibrils which have a tendency to spread at the ends. It produced very little intercellular substance the fibrils of which were thin and varied and corresponded to the flag fibrils described by Mallory. In some of these latter the flag fibrils were matted together and produced a hyaline appearance. These were the chief type of cells as to granular cell with narrow rod shaped nuclei and relatively coarse fibrils that ended in tufts at the ends and corresponded to the myofibrils described by Mallory. Strictly speaking the relative number of cells with fibroglia fibrils appeared to outnumber the cells with myofibrils. Frozen sections were made in pieces fixed in formalin and these stained poorly with Scharlach R. Sudan III and Heidenhain iron. This may have been due to the fact that many of the vacuoles emptied because that the fat existed in a somewhat different state from that readily stained by usual methods. In the gross we were of the fibrous tissue stained bright red with Sudan III.

The portions containing fat were clearly outlined in those which were fat free.

*Diagnosis.* We believe this growth to be a typical example of the so called lipomatous tumors of the uterus but we do not think the correct name for it is open to argument and we are refraining from applying a name to the tumor until after discussion of the histogenesis has been presented.

## DISCUSSION

The histogenesis of lipomatous tumors of the uterus has been differently interpreted by various observers. Knox (10) considered them as supporting Conheim's embryonic cell rest theory (viz. that embryonic fat cells were left behind during development which later produced the tumors). Meckel (quoted by Ellis) thought they originated by the hyperplasia of embryonic fat. Seydel (loc. cit.) regarded them as springing from lipoblastic dislocations because he could not demonstrate the formation of fat cells from either muscle or connective tissue. Another possibility which has been suggested is that of the ingrowth of true fat tissue along the vessels or the nerves from neighboring structures. Bruennings (8) favored the view of the change of muscle cells into fat cells. Franque and Jacobson attributed the development of the fat cells to the infiltration of connective-tissue cells by fat globules.

The above theories fall into one of the two groups depending on whether or not the tumor cell is held to be a true fat cell arising from a lipoblast or to be some other type of cell which has merely taken up fat. The theories of Knox and Meckel are so closely associated that they may be discussed together. Mallory (18) makes the statement that fat cells are perfectly definite cells formed by differentiation from mesenchymal cells and are neither fibroblasts nor derived from fibroblasts. R. Meyer states that embryologically no fat cells occur in the uterus, broad ligaments or myomata. So that if we accept the views of these two authorities the cell rest theory in the strict sense is automatically excluded on the very obvious grounds that if such cells were at no time normally present they could not remain as rests and start to grow at a later time. On the other hand as long as one attempts to interpret these tumors as lipomata, he must grant that they can spring only from lipoblasts and if lipoblasts are not normally present in the uterus during development they can occur only as embryonic displacements and thus Seydel's view becomes the only tenable one.

The extension along the vessels and nerves is very unlikely both because of the thick cap-

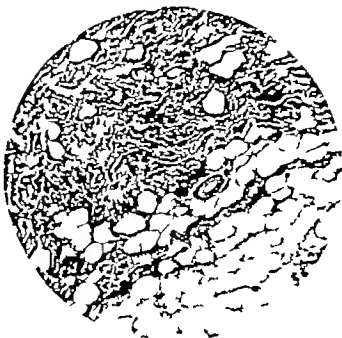


Fig. 5. Microscopic section from the junction of normal fat with a so-called fibroma of the breast showing a similar picture to that seen in Fig. 4.

sule and because of the constant finding of the larger vessels near the centers of connective tissue hundles and not in the fatty areas.

The whole difficulty lies in our inability to say that the large fat cells were not derived from connective tissue cells. The fibroglia fibrils which are the only definite means of identifying connective tissue cells could not be demonstrated in connection with fat-cells and aside from the globular fat contents we know of no characteristic structures by which to identify a fat cell so that we could not be sure that after all we were dealing with true fat cells. We know that highly specialized cells such as heart muscle cells, striped muscle cells, liver, adrenal and glandular epithelial etc. can and do take up fat in a globular form and it seems reasonable to think that connective-tissue cells which are certainly less specialized may do the same thing. Many smooth muscle cells were identified by their fibrils and none was found to contain either granular or globular fat so that we feel that the histogenesis of the tumor has been narrowed down to one of two cells, true lipoblasts or connective-tissue cells. The points which favor the lipoblastic displacement theory are: (1) The chief cells are typical fat cells, their nuclei are crowded to the peripheries of the

cell they have no characteristic fibrils and in the average single field, the tumor tissue could not be distinguished from ordinary subcutaneous fat. (2) In many areas the connective tissue cells can be identified by their fibrils but these cells are not found to contain either fat granules or fat globules in other words there is no shading off of the one tissue into the other the line of junction always being abrupt. (3) In certain instances single globular fat cell of large size are seen completely surrounded by well-developed connective tissue and smooth muscle areas just as if they had been cut off from the fat tissue. The appearance is identical with the fat cell so frequently seen near the margins of normal fat tissue as in the so called fibromata of the breast. (4) All sort of degeneration and necroses occur in leiomyomata and in at least one case we have examined the necrotic area was filled with fat laden endothelial leukocytes and foreign body giant cell yet we cannot recall having seen globular fat in any of these foci. (5) If the condition was due to fatty infiltration of connective tissue cell it should be fairly common because of the frequency of other degeneration in these growth but it has been shown that the rarity of the condition is beyond question. (6) Congenital remain and displacement of several types of tissue are relatively frequent in the female genital tract.

The points which favor the theory that the tumor forms from connective tissue cells by fatty infiltration are: (1) Identified connective tissue cell with typical fibrils were so closely associated with the fat cell that one hesitated to differentiate between them. (2) Infiltration of many cells by fat globules is a recognized process to which connective tissue cells are not known to be immune. (3) The age of the patients from whom such tumors have been taken is rather beyond the usual time for the development of congenital tumors. The ages were given in eight of the quoted cases and ranged from forty-two years in the youngest to sixty-eight years in the oldest with an average age for all eight cases of fifty-seven years. This point has never been held as a

very strong one against the cell rest theory of cancer and we do not wish to lay too much stress upon it.

We make no claims to having settled the question in general but in our case we think that the bulk of the evidence was on the side of the lipoblastic displacement theory and for this reason we have diagnosed our tumor as a lipoma. We have considered the connective tissue cell present simply as a part of the stroma and the muscle cells as accidental inclusion in the tumor and not as evidences fit, having been of mixed origin.

#### CONCLUSIONS

1. Fatty tumors of the uterus come from one of two sources either lipoblastic displacement or connective-tissue cells which have undergone fatty infiltration.

2. The lipoblastic displacement theory offers the best explanation of the findings in the above case.

3. Having accepted the lipoblastic displacement theory for the explanation of our tumor we believe it to belong to the class of simple tumors and that it should be called a *lipoblastoma uteri*.

We wish to express our indebtedness to Dr S. A. King of the Allegheny General Hospital of Pittsburgh for the privilege of reporting this specimen.

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## A STUDY OF ONE HUNDRED CONSECUTIVE FRACTURES OF THE SHAFTS OF BOTH BONES OF THE FOREARM WITH THE END-RESULTS IN NINETY-FIVE<sup>1</sup>

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THE following study is based entirely upon observations of cases treated at the Presbyterian Hospital Out Patient Department between 1912 and 1915. The purpose throughout the series has been to improve our own methods of treatment of fractures of both bones of the forearm by a careful study of end results. Necessarily our ideas have changed from time to time and consequently some of our methods. The essential principles in treatment however have been adhered to throughout the series.

### ANATOMICAL FACTORS

The important mechanical factors to be borne in mind in considering fractures of the shafts of radius and ulna are: First the action of the pronators and the supinators of the forearm, the pronators chiefly affecting the positions of the fragments in fractures of the lower half, the supinators affecting the positions of the fragments in fractures of the upper half of the shafts. Second the relation of the radius to the wrist joint results in its bearing the brunt of the transmitted force from hand to forearm in cases of indirect violence and explains the preponderance of displacement in the radius in these cases. Third the question of stress and strain in relation to the frequency of fracture of the lower one third of the radius.

### UNFAIR COMPARISONS OF STATISTICS OF OPEN AND CLOSED REDUCTION

Statistics relating to the open reduction of fractures are usually based upon the work of surgeons specializing in that particular branch of surgery. Their results are compared with the inaccurate statistics of out patient departments or emergency wards of hospitals where the fracture work is too often carried on by inexperienced internes working alone without the help of anæsthesia, fluoroscope or late roentgenograms. If the same sur-

geons were to reduce the same type of fracture with as great care and with as many assistants to help in the immobilization as they receive in the operating room, their end results as to function and the time that the patient is incapacitated would be as favorable if not more favorable than that obtained by the open method.

We do not advocate the common methods of closed reduction; on the contrary we condemn them as they are usually carried out. The one man reduction without anæsthetic without fluoroscope and without subsequent roentgenograms, the usual methods of immobilization with poorly coapting anterior and posterior wood splints and the continuous immobilization of the forearm for a period of four to six weeks without the use of massage and proper active and passive motions in such splints, these we condemn and agree with those who argue for open reduction in preference to such methods of closed reduction. The methods we have used in this series of one hundred cases differ radically from the usual methods of closed reduction in many particulars. They are not the method of any one school but are a combination of what we have found to be the best methods of several surgeons and of several points in treatment which we developed as we learned by our successes and mistakes.

### TREATMENT

If any reduction is necessary it should be done immediately. In a hospital with fluoroscopic facilities in every case in which a diagnosis of fracture of radius and ulna has been made or suspected the patient should have the privilege of fluoroscopic examination first to determine the necessity of reduction and second to prevent the possibility of incurring displacement from manipulation. It has been our experience that easy and complete reduction varies directly with the length of

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Fig. 1. Reduction under the fluoroscope with the help of the tensor of lateral planes, a successful though not complete. Not the correct position of the nail. d 1 cm from the end of the nail. Half year after reduction. b one day after reduction. c one month after reduction. d 4 months after reduction. e 6 months after reduction.



Fig. 2. 1 year and 6 months after reduction. 1 year and 8 months after reduction.



Fig. 3. 1 year and 8 months after reduction. 1 year and 10 months after reduction.



Fig. 4. Reduction after the first fracture was necessary. At the time of the second fracture, in order to obtain reduction it was found necessary to nail the forearm to the side of the rest of the arm at an angle. It is an end of the fragment in plain view under the fluoroscope. First fracture no reduction. b reduction after 1 month. c reduction after 2 months. d reduction after 3 months. e reduction after 4 months. f reduction after 5 months. g reduction after 6 months. h reduction after 7 months.

time following the fracture the earlier the reduction the easier it is and the more complete. The tissues are less traumatized and therefore repair is better. We base this conclusion upon the study of the microscopical sections of tissue removed from between the ends of fragments taken at successive stages of repair. These sections prove more conclusively than any argument the necessity for reduction at the earliest possible moment.

*Anesthesia* If reduction is found necessary the fracture should be reduced with the patient under general anesthesia. This provides complete muscular relaxation which is essential for reduction; it frees the patient from pain and enables the surgeon to work deliberately. The anesthesia of choice is nitrous oxide-oxygen in patients more than six years of age; drop ether in younger children. Gas-oxygen secures sufficient muscular relaxation for purposes of reduction; the patient recovers consciousness almost immediately after reduction and is able to return to his home without the discomfort and lassitude following ether or chloroform. More over gas-oxygen can be given at any time and without the necessary delay of several hours after the ingestion of food. This is an important point inasmuch as the majority of patients come to the hospital soon after eating. Where one has not a gas-oxygen apparatus nitrous oxide alone or with ether is satisfactory.

*Use of fluoroscope* The chief argument put forward by the advocates of open reduction is that their work is done with the ends of the fragments in plain sight. There is no denying the advantages of reduction of a fracture with the ends of the fragments visible and it is just this advantage that we advocate in the use of the fluoroscope for closed reduction. This point has not been sufficiently emphasized by recent writers nor are the advantages to be gained by the use of the fluoroscope sufficiently appreciated by those doing fracture work in hospitals where fluoroscopic facilities are at hand. With the patient under general anesthesia satisfactory visible manipulations of the fragments for purposes of reduction can be had by using the fluoroscope. This is especially true in

children. In a number of our cases where there was marked overriding of the fragments and where full angulation of the fragments was necessary to secure end-to-end apposition we were able to get complete reduction by producing extreme angulation of the forearm; the ends of the fragments being under visible control all the time. It is in the reduction of fractures of the radius and ulna that the fluoroscope is especially advocated because in these fractures the bones are easily seen. There are four fragments with which to deal and the assurance of good reduction gained by palpation of the fragments is not comparable to the combined evidence of palpation and inspection. Another very great advantage and one that was of the utmost value to us in a number of our cases is the assurance that the fluoroscope gave us in manipulating the fragments without the fear of causing an increase in the displacement of the fragments especially was this true in complete fracture of one bone and in complete fracture of the other. In a great many fractures we were able to avoid increasing the displacement, or causing any displacement when we saw that the fracture was an incomplete one but we did not hesitate to increase the displacement when by so doing we were able to get an end-to-end apposition. In this series of cases in many of which fluoroscopic reduction was used we have been unable to detect ill effects from injury to soft parts or from the roentgen rays. A permanent record of the reduction afforded by an X-ray plate is of course essential.

*Importance of adequate assistance* Reduction should be carried out with ample assistance. There should be at least three men preferably four: the surgeon, the anesthesiologist, one assistant to exert traction, another to exert countertraction or assist in the manipulation. This is always insisted upon by the surgeon in doing an open reduction and the same care exclusive of surgical technique should be taken in the reduction by the closed method. Intelligent assistance is essential in reducing these fractures especially at the time that the plaster splints are being applied. We heartily endorse a mechanical apparatus such as the Hawley table.





Fig 3 Reduction in this case as obtained without the fluoroscope. The radial bowing of the radius, evident in the roentgenogram is not seen. The contour of the forearm now has it affected the function in an. (One day before reduction b 24 da. after reduction c 3 years after reduction d 3 years after reduction)



Fig 5 Three years after reduction



Fig 4 9 months after reduction



Fig 4 Reduction in this case was unsuccessful 3 attempts. The displacement was increased. In this case the fluoroscope was not used it being out of commission at the time. Notwithstanding the marked displacement the end result was excellent. (First da. first attempt b second da. second attempt third day third attempt d four months after reduction e 9 months after reduction)

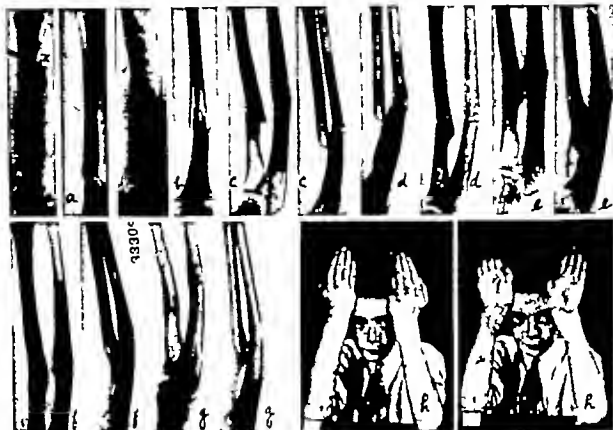


Fig 5 Reduction in this fracture of the upper and middle thirds was unsuccessful. Notwithstanding the displacement of the fragments, the end-result was entirely satisfactory. The fluoroscope was not available for this case at the time of attempted reduction. *a* Fracture one day old *b* 7 days old *c* 25 days old *d* 33 days old *e* 3 months old *f* 9 months old *g* and *h* 13 months old

Every effort should be made to secure reduction at the first trial. Too often an incomplete reduction is allowed to stand either due to the fact that the patient was not under anesthesia or because the relative positions of the fragments could not be made out by palpation. The patient is frequently sent home to return the next day or two days later for a roentgenogram. Thus more often than not means a delay of three or four days and when a second attempt at reduction is evidently necessary the most favorable time for reduction has passed.

*Positions for immobilization.* The question of the position of the forearm and the best method for securing immobilization of the forearm is one that has caused an almost endless discussion and in which there is very little agreement. And in this regard we feel its importance has been greatly exaggerated. Many of the French surgeons are loud in their praise of the position of extreme supination. Their arguments are based

almost entirely on anatomical grounds their reasoning being that the position of supination corrects the rotary displacement of the upper fragment of the radius due to the flexing and supinating action of the biceps and supinator brevis muscles. This undoubtedly holds true in the fractures of the upper third of the forearm especially where there is overriding of the upper fragment of the radius. But we do not think that this holds true in the other sites. Our procedure consequently varies with the site and the presence of overriding. If the fracture is in the upper third we immobilize the forearm in supination and flexion beyond the right angle. If the fracture is in any other site we immobilize in the position of midpronation and supination and flexion beyond the right angle. This is very comfortable and has given us uniformly good results. It must be said that the position of extreme supination for any length of time increases the discomfort of the patient considerably.



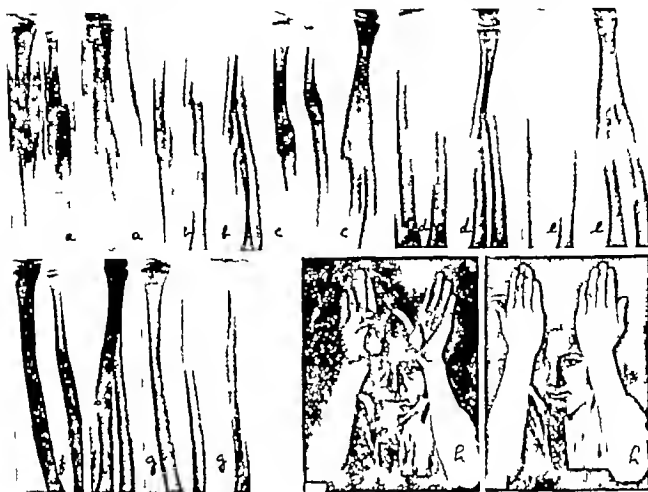


Fig 7 This case is of unusual interest in showing the end result of an unreduced fracture. Note the remarkable restoration of the contour of the radius and ulna and the disappearance of the spike on the upper end of the lower fragment of the radius. The end-result is normal contour normal function a third day after second attempt at reduction without fluoroscope b 1 month after reduction c 3 months after reduction f years 2 months after reduction g and h end-result 3 years after reduction

forearm is efficiently prevented and the failure to do this is the one unpardonable fault of the anterior and posterior splints especially the wood ones which are so commonly used at the same time a certain amount of flexion and extension at the elbow is possible. Another advantage is that small pressure pads can be applied on either side of the forearm without disturbing the splint. In passing we would say that we have used this pressure padding to very great advantage during the "stick" stage in correcting bowing of the fragments where it has persisted after reduction. The splint is very easily removed and replaced. The only precaution that we would emphasize in the use of this splint is the importance of making sure that the splint is wide enough and that the lower borders of the splint when applied are close together

to prevent the forearm from sagging between the lower edges of the splint.

#### AFTER TREATMENT

Treatment after reduction consists in baking, massage, and active and passive motions. For the first three or four days the patient is asked to return to the clinic every day for inspection of the forearm and splint. Depending upon the fracture the dorsal portion of the splint may be lifted and the dorsum of the arm massaged very lightly and then while the elbow rests in a vertical position on a table with the forearm firmly held to the dorsal part of the splint the ventral portion of splint may be held aside and the ventral portion of the forearm lightly massaged after which the splint is bandaged in position. If there is continued pain and swell



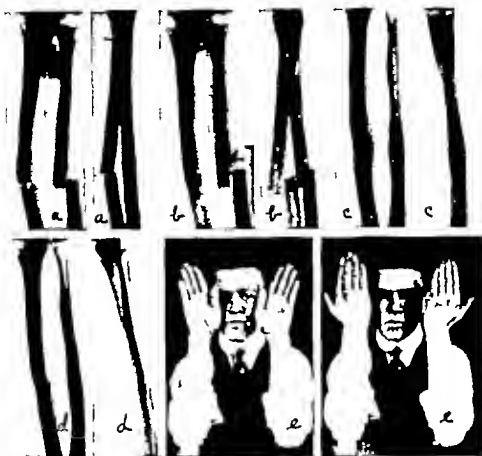


Fig 9. After three unsuccessful attempts at reduction without the fluoroscope open reduction was advised and performed by Dr Joseph A. Blake. The fragments were reduced and immobilization was done without insertion of any foreign body. The result is normal contour, normal function. This is the only open reduction in the series of 100 cases. a First day b seventh day after three attempts without fluoroscope c months after open reduction d three years after

ment and subsequent follow up notes regarding repair and function are absolutely necessary for the history analyses. Certain precautions we found very important in our follow up work. These are

- a. Correct recording of patient's name, address with floor, front or back, east or west, north or south (in tenement work).
- b. Obtaining the number and district of public school.
- c. Obtaining the name and permanent address of at least one friend outside of immediate family.
- d. Taking a very personal interest in the patient as well as in his or her lesion.
- e. Never allowing too long intervals to elapse without some sort of communication with patient.
- f. Obtaining the co-operation of an enthusiastic, persistent and intelligent social service worker.

#### CONCLUSION

In drawing conclusions from this series we wish to emphasize the fact that the ma-

jority of our cases were in children. These conclusions are based upon end results averaging eighteen months in 95 per cent of our series of one hundred cases.

1. Using the end result as the standard, open reduction for fracture of both bones of the forearm in children is unnecessary.

2. Reduction should be done at the earliest possible time. To wait for the swelling to go down is bad surgical practice because it is ignoring a cardinal principle of the repair of wounds in bone as well as in soft parts.

3. Fluoroscopic examination should be used to determine the necessity for reduction and to insure the best reduction with the least trauma. Every hospital where fractures are treated should be equipped with good fluoroscopic facilities and a radiographer should be on emergency call to supervise the fluoro-



TABLE I—CONTOUR OF FOREARM

Function		Normal	Excellent	Fair	Bad	
	Normal	8	6			84
	Excellent	3				4
	Fair					
	Bad					
		8	6			

Of the 84 normal results the question of reduction was not needed in 74  
 Of these 4 cases reduction was considered necessary in 23  
 In 51 cases unnecessary in 20  
 In the 5 cases reduction was accomplished in 12  
 Reduction was partially accomplished in 13  
 Reduction was unsuccessful in 6  
 Displacement was increased in 6

TABLE II—REPORT OF THE COMMITTEE OF THE BRITISH MEDICAL ASSOCIATION NON-OPERATIVE TREATMENT OF FRACTURE OF THE SHAFTS OF RADIUS AND ULNA

Age Group	Number of Cases	Anatomical Result			Functional Result			Good Anatomically Good Functionally
		Good	Fair	Bad	Good	Fair	Bad	
0-10	20	8	5	7				65
11-20	6	6	4		3	4	4	56.6
Total	26	14	9	7	13	8	6	61

The only series that we have been able to find in which the end results in fractures of both bones of the forearm are carefully recorded is that reported by the committee of the British Medical Association. This committee reported the result of a very careful investigation in *The British Medical Journal* (1912 vol. II p. 505). We compare this table with a similar one tabulating our end results.

END-RESULTS OF NON-OPERATIVE TREATMENT OF FRACTURE OF THE SHAFTS OF RADIUS AND ULNA IN THE PRESBYTERIAN HOSPITAL SERIES

Age Group	Number of Cases	Anatomical Result			Functional Result			Good Anatomically Good Functionally
		Good	Fair	Bad	Good	Fair	Bad	
0-10	5	5			5			100
11-20	35	33	2		33	2		100
Total	40	38	2		38	2		97.5



Fig. 1. a Shows the plaster strip with one of the flannel edges turned over the other still flat. b Shows the sugar tong as it appears when bandaged to the forearm. Note the position of the elbow in flexion beyond a right angle the forearm in midpronation and midsupination. c The splint removed. Note the greater approximation of the inferior or ulnar margins as compared with the superior or radial margins.





[illegible]

† Detail of clinal bands

[illegible]



## CARDIOLYSIS

A FURTHER REPORT WITH NOTES UPON AN ADDITIONAL CASE

BY JOHN E. SUMMERS, M.D. OMAHA, NEBRASKA

FOUR years ago at the Cincinnati meeting of this Association I presented a paper entitled *Boning of the Thoracic Precordial Wall in Certain Affections of the Heart*. Report of a case—the case being one of mediastinopericarditis treated by cardiolyis after the suggestion of Brauer. In introducing the subject I remarked that this procedure cardiolyis or pericardiac thoracolyis has found no favor in America why this is so is incomprehensible to me because the operation is based upon good mechanical principles is not difficult of execution neither has it a high mortality. The danger of the procedure is so inconsiderable in proportion to the good to be expected that every physician should familiarize himself with the diagnosis of the conditions calling for the operation and every surgeon should in addition to this learn the technique. Let me briefly recapitulate the history of cardiolyis and the indications and contra indications for the procedure.

In pericarditis according to Brauer whenever the heart becomes adherent to the pericardium and the pericardium to the mediastinum pleura, and chest wall, a great burden is added to the function of the organ. In systole it tugs against the bony chest every beat being a strain upon its musculature but the more evident the sign of tugging the better the condition of the heart muscle and the more surely will relief come to it if the overlying bony wall is removed changing it into a movable elastic wall formed solely by musculocutaneous flaps. Internal adhesions of the pericardium to the heart may not of themselves be of great moment, and usually are difficult to diagnose but if with their occurrence the pericardium itself becomes adherent to neighboring organs, as the mediastinum, diaphragm sternochondrocostal wall the function of the heart will be interfered with in degree comparable with the elasticity of these adhesions. The

chest wall itself except in the intercostal spaces yields scarcely any at all consequently the heart muscle gradually becomes weaker and weaker as a result of the strain. It is in this latter condition before the heart muscle itself is worn out as evidenced by damming back symptoms that Brauer proposes the operation of cardiolyis, or as I in my paper called it, boning of the precordial wall.

Brauer postulated that for the success of the operation the following conditions must be present diastolic shock, systolic retraction at the apex and the ability of the heart muscle to compensate. If from myofibrosis myocardial degeneration or from valvular disease, the heart is unable to compensate the operation will be futile. If threatened heart insufficiency is not too marked, if the liver is not too large and ascites too great much relief may be expected. But above all the patient must be one whose heart still responds to medication and relief from all strain this in itself is proof that there is still tone in the heart muscle and that it will be markedly benefited by untethering its fastenings to the chondrocostal chest wall. Hearts weaker than this will scarcely be benefited by operation and will tend to bring any operative procedure into disrepute. Anatomically and to a lesser extent clinically pericarditis may be divided into the following types diaphragmatic pleural chondrocostal and mediastinopericarditis. The cases may be said almost never to be of the pure type. The existence of the chondrocostal type is necessary if we are to expect anything from operative interference. The heart is hitched fore and aft to the chest wall and to the vertebral column by involvement of pleura pericardium and posterior mediastinum. It is at this double pull that our therapy is directed. Another indication for removal of the precordial chest wall is brought forward by Morrison. In a patient with cor bovinum

from mitral and aortic diseases who suffered from frequent and severe anginoid pains that resisted treatment he removed  $4\frac{1}{2}$  inches and  $5\frac{1}{2}$  inches of the fifth and sixth ribs respectively. The result was subjectively and objectively gratifying so that the patient was able to earn his living which he had previously been unable to do. He was reported much improved one and one half years after the operation. As indicated above the principal diagnostic signs of adhesive pericarditis are systolic retraction at the apex, the diastolic shock epigastric diaphragmatic tugging Broadbent's sign and cardiac and pulmonary immobility. For a more complete exposition of this subject I will refer you to my former paper and like wise to a paper by Dr. Arthur D. Dunn and myself on mediastino-pericarditis published in the *American Journal of the Medical Sciences* January 1913.

My chief object today is to report the subsequent history of the patient operated upon in March 1912 and also to refer briefly to a second case and report the result.

It may be recalled that my first patient a young man 39 years of age, presented clinically all the symptoms which I have said were essential to the diagnosis of mediastinopericarditis. In addition, he could not lie down without several pillows under him, spent his nights largely in a chair, he was unable to move without choking and coughing, could eat but little, the abdomen was distended, the bowels would not move without a cathartic, the urine was scanty and highly colored, sharply acid, specific gravity 1.030, albumin present, sugar absent, scrotum, thighs, legs and feet were moderately oedematous. Hyaline and granular casts and red blood-cells were quite numerous. The patient was placed in the Clarkson Hospital, where in the course of three weeks compensation was restored, the heart action became regular, the murmur entirely disappeared and the heart sounds became clear. The patient's temperature was normal throughout the entire time. After a further delay of ten days the cardinal essential for the success of the operation, i.e. compensation, having been brought about by rest and medicinal treatment, cardiolysis was performed. At the time of my report nine months after operation, the man was free from all the distressing symptoms for the relief of which the operation was done and continued so with several slight remissions (attacks of decompensation) able to perform his work as a florist, until this fall. After the work of the summer a severe attack of decompensation made it necessary

for him to stop work and he again entered the hospital under the care of his physician, Dr. Dunn. Notwithstanding rest and proper medicinal treatment after a stay of several months in the hospital the man died four years and ten months after operation. The postmortem examination disclosed the following:

The usual fixation of the pericardium in a broad mediastinal pericarditis. No adhesions between the pericardium and the epicardium, the latter over the left ventricle much thickened, however indicating possible early adhesions to the pericardium. The heart itself very much enlarged, walls thickened, all valves normal and competent. No change in the coronary arteries or in the aorta.

*Microscopical examination.* (1) *Heart.* Greater part of myocardium normal, except for possible slight increase of interstitial connective tissue. Occasional hemorrhage which may have occurred in the course of removal of specimen. Here and there in the myocardium are areas of what are apparently degenerated portions of heart muscle. In these the muscle cells stain more faintly than normal, they are much swollen, the cytoplasm is granular, the nuclei irregular and fragmented. More extreme stages of the same process show in addition, loss of cellular tissue and capillaries. As a rule these changes involve distinct, fairly large areas of myocardium, but here and there can be seen single muscle fibers that show the same change and are surrounded by muscle apparently normal, also the areas referred to above show projections into them of unchanged myocardial tissue. In general, these changes are suggestive of unequal fixation, but it is difficult to explain all these features on this basis. In addition there is fragmentation of certain areas. (2) *Spleen.* Marked passive congestion. (3) *Liver.* Same as spleen. (4) *Kidney.* Marked engorgement of vessels of glomeruli and cortex in general. Very marked parenchymatous degeneration of proximal convoluted tubules, much less pronounced in the distal tubules. Marked oedema of medulla.

After a careful study of the record in this case, there is nothing shown as the cause of the myocarditis with its extreme almost necrotic degeneration of the heart muscle. Repeated Wassermann's had been negative but there is a loop hole through which possibly we may find a reason why cardiolysis was not a more permanently successful procedure. This is that the man suffered from periodical attacks of inflammation of the tonsils and the record indicates that during and immediately following these attacks the heart suffered in consequence. This was thought to be purely the constitutional expression of the tonsillar inflammation and its

specific influence was not considered. Had the tonsils been removed it is suggestive at least, in the light of the knowledge of today that early tonsillectomy would have been a rational practice.

Within the past year I have had an opportunity of performing cardiomyotomy upon a second patient, although one of a somewhat different type and of which I will briefly give the history the temporary rather brilliant result, the cause of the breakdown and the postmortem findings.

A young lady age 3 resident of Denver about four years ago began to suffer from shortness of breath then her feet began to swell, later she developed pain over the precordia. There was a history of rheumatism and the usual diseases of childhood measles scarlet fever etc. Her father died of heart disease her mother from unknown cause two brothers living — one has rheumatism and one has pleurisy. Physical examination, patient thin and anemic slightly cyanotic pericardial friction sound over precordia. Systolic murmur at apex apex in anterior axillary line veins in neck widely congested and cord like. Negative venous pulse, however. Patient orthopneic right border of heart one half inch to right of sternum. Liver enlarged to umbilicus ascites present, and oedema of feet and legs. Lungs rales over bases no fluid. Urine slightly albuminous due only to pus from a mild cystitis. Leucocytes 9600. Weight 11 pounds 1 ounce.

Under the usual heart treatment the oedema disappeared and the pericardial rub subsided more or less than a distinct precordial retraction was manifest. Broadbent's sign was present. Compensation was restored and the liver returned to its normal size. She was operated upon December 14, 1915. Large sections of the third fourth and fifth ribs were removed from the sternum out. In doing this, two accidental incisions were made into the pleural cavity but no collapse of the lung took place. When the ribs were cut away the whole heart fell from the chest wall and found the place made for it. The operation was followed by an attack of suffocative pulmonary oedema, which threatened her life but the oedema gradually disappeared. Following this however a rather general oedema took place which did not diminish under digitalis, notwithstanding which the heart seemed to be in pretty good shape. It was necessary repeatedly to aspirate the pleural and abdominal cavities. The patient remained in the hospital 133 days, and thereafter returned to be tapped, every two or three weeks until August, the intervals gradually growing greater and greater. During this period she was sufficiently well physically to drive an automobile daily. Finally she felt so well that she wanted to go to her ranch in Colorado and per-

sonally drove her car a large one from Omaha to Denver. Later she made a trip across the Rockies, at one time venturing to an elevation of 12,000 feet, and seemingly suffering no inconvenience. She returned to her ranch where she indulged in very hard work. She was a very self-willed young lady and took advice pretty much as suited her temperament. On October 31 she returned to the hospital under the care of her physicians, Drs. Crummer and Anderson, her heart having a few days before, broken down under the strain of too arduous exertion. Decompensation was present in a rather marked degree and attempts at restoration of compensation were hindered because of nausea and vomiting due to passive congestion of the abdominal viscera. The abdomen was aspirated several times and the patient was apparently improving, when, on November 15 after a slight exertion, she suddenly died. A rather interesting coincidence, this girl and my man patient both died in the Clarkson Hospital, on the same day. The postmortem revealed a heart so massive that it practically filled the entire left thorax. Dense bands of adhesion extended from the mediastinum to the right lung at the anterior edge the entire precordium was attached to the ribs and under the sternum. It extended backward into the axilla. The left lung was forced backward in the pleural cavity until it occupied a space scarcely more than if completely collapsed, and was held by adhesions to the pleural diaphragm and pericardium. The parietal and visceral layers of the pericardium were adherent over the entire heart. The liver was enormously enlarged. The findings show that it would have been impossible in this instance to free the heart by such a meager operation as had been done. It would have demanded radical anterior costal excision to the axillary line and likewise of a part of the sternum. No microscopical examination was made.

As I stated formerly and in the beginning of this paper it is incomprehensible to me why Brauer's operation has received so little consideration in America so far as I am informed, my cases are the only ones that have been done here. Altogether in Germany France and England 38 patients have been operated upon. Perhaps this dearth of operation for the relief of a progressively bad pathology may be best explained in that physicians in general do not accurately differentiate the lesions of the heart and of its sac, and when cases of mediastinopericarditis are recognized the hope of cure by surgical means has long time passed. The fault is not with the operation.

A word again as to technique practically nothing is found in the English literature

about this procedure Only one of our text books (Johnson's) gives it place. He says

The operation was devised for the purpose of removing the ribs which imprison the heart and interfere with the cardiac systole. The rigid bony wall of the thorax is thus replaced by a soft elastic covering which is easily moved by the heart, and part of the cardiac power which previously had been wasted in overcoming the resistance of the thoracic wall, is conserved. The removal of the bony framework of the chest also permits the heart to drop back into the thorax, thus relaxing the lateral or posterior adhesions which may be present.

In order that this may be accomplished it is essential that the ribs be removed in such a way that there can be no re formation of bone i.e. they must be removed with all of their periosteal covering Although it is not easy to remove the posterior periosteal covering of the ribs still it can be done and it is no

material disadvantage if in the doing the pleura is opened once or several times. The lung does *not* collapse and the injury is easily repaired besides intratracheal insufflation anaesthesia can be employed if desired this would eliminate any possibility of lung collapse Johnson makes the statement that the periosteum which has been detached by the incision along the middle of the rib is ablated after the removal of the ribs in so far as this can be done without endangering the pleura It is in my opinion a mistake to limit the removal of the periosteum to that which has been detached by the incisions along the middle of the ribs this limitation being done to prevent the supposed dangerous consequences of pleural injury Our knowledge of modern surgery of the chest does away with this bugaboo

## TUBERCULOSIS OF THE HIP JOINT

By JAMES K. YOUNG M.D. F.A.C.S. PHILADELPHIA

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IT was formerly the experience of orthopedic surgeons to treat many cases of tuberculosis of the hip-joint which were complicated with abscess and deformity but by the modern methods combinations of fixation and traction have eliminated these serious complications thus greatly shortening the length of the disease.

During the writer's early experience in the field of orthopedic surgery it was the custom to treat all cases of hip disease with a long Taylor traction splint and this was the routine method of treatment that I became familiar with while under orthopedic training with Dr A Sydney Roberts Subsequently during my association with Dr De Forest Willard I gained a familiar experience with the Thomas fixation splint for ambulatory cases and the employment of simple traction for bed cases For the last eight or ten years I have been using an original traction fixation splint.

The Taylor splint possessed certain advantages in that it made traction upon the joint,

separating the joint surfaces thus relieving spasm but it had these defects the foot was not securely fixed and rotation of the hip-joint upon itself was possible Another disadvantage connected with its use was its narrow pelvic band allowing of too much flexion and extension This was in a measure corrected by means of a strap passing across the top Deformity not infrequently occurred requiring subsequent operation The Thomas splint provided fixation and prevented flexion so that deformity did not occur The original combination splint overcame all these objections the trunk was securely held by the body portion flexion and lateral deformity were prevented and traction applied to the limb relieved the joint pressure and muscle spasm

Throughout all this treatment, an effort was made to hasten recovery and secure a movable joint without ankylosis. This plan is diametrically opposed to the treatment as recommended by Lorenz and referred to as weight bearing therapy in tuberculous hip



diseases which is based upon the assumption that it is impossible to secure in many cases a movable joint and that the end result should be an ankylosed joint in a good position for locomotion.

Just here it seems advisable to parenthetically state the method of Lorenz and the application of spica dressings in treatment of this class of cases. Much attention has been directed in the treatment of hip-joint disease to the employment of long and short spica dressings because of the eminence of its originator. Very shortly, however it became only too apparent that much injury resulted from the unskillful use of the method and that it was necessary to enlighten the practitioner in regard to it. The principle has been stated by Werndorff as spokesman for this distinguished authority. We came to the conclusion that the end result of coxitis therapy should be an ankylosed and not a movable joint. After considering the question of traction or weight bearing Lorenz decided that the only salvation of the hip-disease afflicted individual was to be sought in the ankylosis of the joint. With this end in view the limb was fixed in either a long or a short hip spica with the part abducted and the patient was then allowed to walk upon the diseased limb. These casts were applied under an anæsthetic. In the hands of a skillful surgeon of very large experience as in the case of Lorenz some cases recover but in others abscesses form and deformity is engendered, and in every way this method of treatment becomes a decided regression. If the splint be applied to an acutely inflamed joint, it is almost certain to be followed by abscess formation and complete destruction of the joint. From personal experience, the writer can testify as to the probability of error in the case of a patient under his care who developed a large abscess with shortening and ankylosis after the application of a spica dressing by Professor Lorenz himself.

In all methods of treatment the object should be to obtain a good movable joint, without shortening and without deformity.

As a result of much experience it has unquestionably been found that this my original method here outlined, cannot be used to

advantage in hospital work or outpatient ambulatory cases, as these classes of cases do not possess sufficient intelligence or persistence or attentiveness in their attendance to obtain the best possible results.

Modified forms of treatment have been employed with some measure of success but throughout this article it is to be understood that we are dealing with *private* orthopedic cases.

#### DIAGNOSIS

The diagnosis of tuberculous hip disease must be made positive (a) by clinical examinations (b) by means of the roentgen rays (c) by means of laboratory methods.

*a Clinical examinations* Of late years too little dependence has been placed on a correct interpretation of the disease as revealed symptomatically at the bedside and emphasis should be placed on the earlier method of diagnosis because within recent years too much attention has been given to the roentgen rays and to laboratory methods. The diagnosis should always be made first *clinically* and these deductions should be unerringly confirmed by laboratory findings.

The two symptoms which are markedly characteristic of tuberculosis of the hip-joint are spasm and atrophy. These spasms are tetanic in nature and occur early in the course of the disease. The spasm is soon followed by atrophy and these companion symptoms form a positive part of the symptom-complex in all tuberculous joint affections. In spine disease especially in the lumbar region spasm is often one of the earliest symptoms, antedating the occurrence of deformity. In hip disease the flexors and adductors are the first of the muscles to be affected while at the knee-joint the hamstring tendons may frequently be found contracted very early in the affection.

*b Roentgen rays* The X rays should not be taken to confirm the clinical examination but they do show the location and extent of the disease in the joint. In addition to this the roentgen plate or photograph should be taken every three months in order to study the progress of the disease and to determine the efficiency of treatment. It is difficult to make satisfactory photographs of cases of

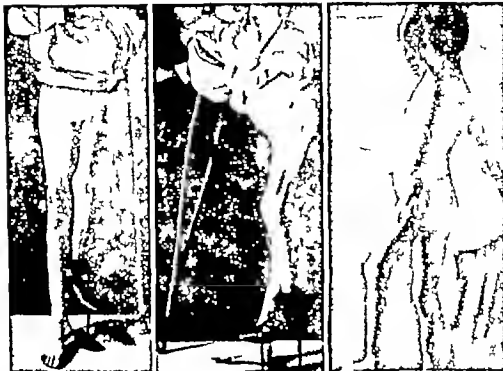


Fig 1 (at left) Tuberculosis of both hips and one knee. (Treated by inefficient methods.)

Fig 2 Same as Fig 1 lateral view

Fig 3 Hip-joint showing excision of hip in a child (Treated by inefficient methods.)

tuberculosis of the hip-joint, because the infiltration into the tissues and the exudation in and around the joint produce a hazy or cloudy effect no matter how fine the technique or how excellent the quality of the material used. A cloudy picture is characteristic of tubercular hip disease and it is only as the disease becomes arrested that the outline of the joint becomes more distinct. The first change observed in the texture of the bone is rarefaction, the picture showing a striated appearance of the cancellous structure more clearly from absorption of the calcium salts at the seat of the disease. The most usual site for the primary focus is in the epiphysis or at the proximal side of the epiphyseal line or at the epiphyseal line in the acetabulum. As the disease progresses favorably the areas of rarefaction become more uniform with the surrounding structures from re-deposits of lime salts. If the progress of the disease is not arrested the areas of rarefaction increase, necrotic islands are cut off and atrophy of the epiphysis and extension upward of the acetabulum occur and finally there is fibrous ankylosis of the

opposing surfaces with eventually the occurrence of true bony fibers connecting the remnants of the trochanter with the ilium.

*c By means of laboratory methods* In order to confirm the results of clinical findings resort must be made to a differential blood count, to the Wassermann reaction and the complement fixation test, tuberculin tests are also of value as well as cultures of fluids about the joint, if they are procurable by means of a diagnostic puncture. In children von Pirquet's test should be employed and while there may be an error of 15 per cent, its use should be tried. In adults resort is made to subcutaneous tuberculin tests. The examination should include cell counting and if there is a great increase in the lymphocytes more than 50 per cent this should rather favor the existence of a tubercular joint affection since the predominance of the polymorphonuclear variety is strongly indicative of an affection non tubercular in origin. The existence of the tubercle bacilli, staphylococci, streptococci, and actinomycosis are readily revealed by microscopic examinations. If the smear slides are not

satisfactory and the culture findings are negative for tuberculosis inoculation of guinea pigs should be resorted to in suitable cases. In all doubtful cases this is my invariable practice. The reports, thus received, are as a rule so tardy in their arrival, that they act as confirmatory measures, rather than as a positive aid in operative interference.

Some years since I had examined by a bacteriologist the fluid taken from twenty-four operative cases under my care, several days before operation all of these being joint cases some of which required excision of the major joints. In this series of cases, six contained the tubercle bacilli six contained pyogenic organisms and twelve were sterile. Among the organisms encountered were, streptococci staphylococci bacilli pyocaneus and pneumococci. Of the sterile abscesses, by means of inoculation into guinea pigs two were negative and one was positive for tubercle bacilli. This critical investigation of the fluid is not important in determining the nature of the disease but it is most valuable in the determination as to what operative measures are to be instituted.

#### DIFFERENTIAL DIAGNOSIS

There are many diseases with which tuberculosis of the hip-joint may be readily confounded, and it is here that mention will be briefly made of several affections from which it must be carefully differentiated. These include

- 1 Non-tubercular synovitis
- 2 Non tubercular chronic arthritis
- 3 Specific syphilitic arthritis
- 4 and 5 Injuries to the soft parts fractures in and about the neighborhood of the joint
- 6 Coxa vara coxa valga
- 7 Arthritis deformans
- 8 Osteomyelitis of the femur or ilium
- 9 Tuberculosis of the fifth lumbar vertebra
- 10 Sacro-iliac displacements
- 11 Sacro-iliac disease
- 12 Malignant disease of the hip-joint.

1 *Non tubercular synovitis* In this condition there is a marked effusion and the capsule is thickened. The joint outline is

enlarged and obliterated. Motion is quite normal and there is absence of reflex muscular spasm. There are also absent atrophy, pain and night cries. Whether the synovitis is septic or not its differentiation from tubercular hip-joint disease can be demonstrated by the use of tuberculin and by diagnostic puncture. The X rays may be of some value, and within a recent period the separation of the joint surfaces by the collected fluid has been demonstrated. The exact character of the septic variety may be determined by a diagnostic puncture or by making a culture of the fluid after operation.

2 *Non-tubercular chronic arthritis* In this affection there is no fluctuation and the capsule is not thickened. The joint outline is distinct and motion is limited. There are present, reflex muscular spasm, marked atrophy and pain upon motion. Night cries are also present.

3 *Specific syphilitic arthritis* In this condition there is slight effusion and there is some thickening of the capsule. The joint outline enlarged and indurated appears with much distinctness. Motion is limited. Reflex muscular spasm is absent the degree of atrophy is slight, pain is moderate upon motion. There are no night cries.

4 and 5 *Injuries to the soft parts fractures in and about the neighborhood of the joint.* There should be no confusion between these and a well marked case of hip disease if the classical symptoms of hip-joint disease are carefully considered and especially if the X rays be the means of corroboration. In old fractures about the neck of the femur the marked limitation of abduction is often most deceptive and has not infrequently led to errors in diagnosis. Yet the roentgen rays will at once clarify the diagnosis.

6 *Coxa vara coxa valga* The foregoing remarks apply equally well to coxa vara and to a lesser degree to coxa valga.

7 *Arthritis deformans* This can be readily dismissed. Children are seldom afflicted with arthritis deformans but when it does occur lesions in other joints make it quite characteristic. Sight should not be lost of the so-called Still's disease, where the characteristic symptoms include arthritis, profuse sweats,



Fig. 4.

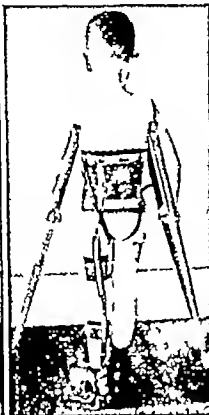


Fig. 5.



Fig. 6.



Fig. 7.

Fig. 4. Anterior view of the author's original hip splint.

Fig. 5. Posterior view of the author's original hip splint.

Fig. 6. Author's convalescing hip splint. Anterior view showing knee and hip locks.

Fig. 7. Posterior view of author's convalescing hip splint.

splenic and glandular enlargements slight elevation of temperature etc. It is in just such cases as these that a thorough clinical examination is of prime importance to eliminate the presence of a tuberculous arthritis.

*8 Osteomyelitis of the femur or ilium*  
Chronic osteomyelitis of the femur is frequently treated over long periods under the mistaken diagnosis of tubercular hip-joint disease. The history of the onset, the lesions in other joints, the X-ray diagnosis and laboratory methods should clarify any error in diagnosis. The roentgen photograph in place of exhibiting a destructive process with areas of necrosis and fibrosis offers a hypertrophic condition with the presence of sequestra. When, however, chronic osteomyelitis is engrafted as a mixed infection upon a tubercular process, the diagnosis, hangs very largely upon the X-ray plate.

*9 Tuberculosis of the fifth lumbar vertebra*  
The contraction of the psoas muscles and the

pains referred to the region of the hip might distract attention from lumbar tuberculosis or malignant disease. The first noticeable symptoms may be the occurrence of a limp and limitation of movement in one limb or the presence of pus in the psoas muscle. This latter phenomenon is usually confined to forced extension, limitation of motion at the hip-joint makes the diagnosis still more masked. In either event, however, muscular spinal rigidity from reflex spasm will establish the true nature of the affection still further corroborated by the existence of a kyphosis.

*10 Sacro-iliac displacements*  
There is little similarity between this condition and tuberculous hip-joint disease. The elongation of the limb is produced by downward displacement of the ilium and there is lameness and pain but the seat of tenderness is entirely different from that in hip-joint disease. In sacro-iliac displacement there is no abduction of the limb there is no shortening

and no pain on moving the hip if the pelvis be fixed.

*11 Sacro iliac disease.* The acute character of the gonorrhoeal infection of the joint with typhoid and local inflammatory symptoms should lead to an early diagnosis. When streptococci and staphylococci are found the symptoms are not so severe and more time is afforded for the careful diagnosis.

*12 Malignant disease of the hip joint.* This affection is rare but great pain, rapid swelling and marked induration should guard the practitioner. All tests for tuberculosis should be invoked in an effort to arrive at a diagnosis by exclusion. Subsequently the microscope will determine the true character of the process whether sarcoma or carcinoma.

#### TREATMENT

The author's method of treatment is divided into two parts: first the use of a fixation traction splint during the acute stage; second, the use of a convalescing hip-splint.

*Author's splint.* This splint (Figs. 4 and 5) is made from a plaster of Paris cast and extends from a point midway between the costal border and the axilla to the toes on the affected side including the trunk and leg. The thigh is slightly abducted and the knee slightly flexed. From this a leather body-portion and a leather thigh and calf portion are made the splint being reinforced by a posterior steel or other metal bar, the bar terminating in a plate which secures the foot in dorsal flexion. Perineal straps form part of the splint and by means of an ankle and straps traction is made upon the limb relieving the joint spasm. The patient wears a wooden and cork patton on the sound foot and walks upon crutches. Great care is used to extend the limb from time to time

so that a uniform traction is maintained, and provision is made in the splint for the growth of the individual. The splint is worn from twelve to eighteen months. It is removed once a week and the limb is carefully examined every month and gently moved by the surgeon only at this time.

The progress of the disease is carefully observed through the clinical symptoms and a study of the roentgen rays.

*The convalescent splint.* When all the symptoms have disappeared and the rays reveal the presence of lime salts and healing has occurred the author's convalescent splint (Fig. 6 and 7) is applied. This consists of a pelvic band with a lateral steel bar extending from the pelvic band to the foot plate and is worn inside the shoe and joined with lock at the knee and at hip and secured in place by broad leather calf and thigh bands. Perineal traps are used. The patient wears ordinary shoes and goes about without crutches, the weight being borne on the perineal traps. The splint is locked while walking and it is never unlocked until from three to six months have elapsed. Then the patient unlocks it when sitting down.

#### RESULTS OF TREATMENT

While formerly there were 50 per cent of abscesses in all cases of hip-joint disease by all forms of treatment and whereas deformity was commonly observed, the present method in private practice has resulted in one case of abscess out of a large number of cases. In my own experience during the last eight years and the occurrence of deformity and ankylosis have only been a rare exception. There have been no deaths. Formerly the percentage of deaths were 24 in 1000 or approximately three tenths of one per cent.

HYDATID CYST OF THE LIVER WITH REPORT OF TWO CASES<sup>1</sup>

BY GEORGE BEN JOHNSTON, M.D. AND MUKAT WILLIS, M.D. RICHMOND, VIRGINIA

WE have had two cases of hydatid cyst of the liver during the past two years and about six months ago another case was operated on in a Richmond hospital. This is remarkable because of the fact that prior to 1913 only two cases of *tænia echinococcus* infection were reported from Virginia and two hundred and fifty from United States and Canada. The Virginia cases occurred in Alexandria and Staunton. There was however another case that was infected in Virginia, but was reported from Buffalo by Cary and Lyons.

During the winter of 1913-1914 several epidemics of *tænia echinococcus* appeared in Virginia raised hogs. In one consignment from Charles City County slaughtered in Richmond under the supervision of the Bureau of Animal Industries there were forty-six animals and all forty-six were infected with the *tænia echinococcus*. In another shipment from Goochland County there were eight hogs five of which were infected. In a number of small consignments during the winter of 1913-1914 there were one or more animals infected with this parasite. In November of this year in a shipment of sixty hogs from Charlotte County fifteen were infected with hydatids (25 per cent).

Dr Hall states in *Bulletin 206 U S Department of Agriculture* that recent abattoir figures show an alarming prevalence of disease in domestic animals in some parts of this country, notably in certain localities in Virginia, Arkansas and Oklahoma and the prevalence of hydatids in domestic animals is an index of the danger to which people are exposed. The bare fact that hydatids occur at all in the United States is of itself a cogent argument for the suppression of the dog nuisance as a measure necessary for the public welfare.

It may be a mere coincidence, but to us it is more than one that the sudden increase of *tænia echinococcus* in human beings should parallel an increase of the condition in hogs.

Can there be a relation between the two? If not, are the dogs in Virginia more heavily infected than formerly? These questions are extremely interesting but difficult of investigation.

Dr Marshall tells us that it has been his observation that hogs raised in a small pen are more frequently infected with hydatid disease than hogs raised with ample pasturage. The hogs that are particularly prone to this infection are those which are fed from the table and kitchen refuse. He explains this by the fact that the smell of food attracts the dog in consequence of which the farmer feeding his hogs is invariably accompanied to the pen by a dog. In this way the hogs come in close contact with dogs or with the egesta from dogs and the dangers of infection are thereby accentuated.

If there is any relation between hydatids in men and hydatids in hogs we would naturally look for it in rural districts because in these districts the slaughter of animals is not supervised by the Bureau of Animal Industries and there the hogs are more frequently infected and the offal is not as carefully dealt with as in the abattoirs where inspection is rigid.

Man may be directly infected from careless use of infected organs but we are inclined to think that most of our *echinococcus* infections are traceable to the water supply to raw vegetables contaminated by egesta from dogs and to dogs themselves. The disease however is conveyed to the dog by the eating of infected organs and in this respect the hog is active in keeping alive this condition in certain localities in Virginia.

Our two cases came from the rural districts and they were frequently exposed to infection both from dogs and from meat that was not properly inspected. The case that was operated on in Richmond several months ago occurred in a foreigner who had lived in this country a short while. Our cases however were not from the region in which the epidemics in hogs were reported.

Geographically *tænia echinococcus* is a widespread disease and in certain countries it occurs with great frequency especially is this true in Iceland and Australia. In the former country according to the statistics of Gallot, about one out of thirty of the entire population is infected. In Australia the returns extending over many years of the Mount Gambier Hospital show one hydatid patient for every sixty five admitted for all complaints. In both Iceland and Australia sheep raising is done on a large scale and a survey of the geographical distribution of the hydatid disease leads to the conclusion that sheep and especially fine woolled sheep such as the Merino breed are responsible to a large extent for the infections in dogs. In Australia and Iceland 40 per cent of the unregistered dogs were found to be infected.

We believe that the hog is playing the same rôle in Virginia that the sheep is playing in Australia and Iceland and that if a search were made we would find that *tænia echinococcus* is more frequent in Virginia dogs than we suppose, and further that the *tænia echinococcus* infections are increasing among them. According to Hall the prevalence of hydatids in dogs is an index of the danger to which people are exposed. If this be true we naturally look for more infections with *tænia echinococcus* in man throughout Virginia.

*Echinococcus* in man shows two forms the *echinococcus hydatidosus* and the *echinococcus alveolaris*. Both of our infections were of the hydatid type. The alveolar type is seldom seen in this country but is fairly common in some parts of Austria and Germany. The alveolar type is usually a fatal infection.

The distribution of hydatids in the body according to the table compiled by Thomas shows the different organs are attacked in the following percentages: liver 57, lungs 11.6, kidneys 4.7, brain, 4.4, spleen 2.1, heart 1.8, peritoneum 1.4.

The *echinococcus* cyst originates primarily from a little tape-worm found in dogs. This tape worm sheds off its terminal proglottis which is filled with a large number of eggs. This passes out of the intestinal tract with the excreta and sooner or later the eggs are liberated from the proglottis and they may float about

on particles of dust, or they may be carried to a neighboring water supply. Human beings and domestic animals drinking this water or inhaling dust are subjected not to a tape-worm infection but to an infection characterized by the presence of hydatids or bladder like bodies in the different organs.

The eggs which are taken into the gastrointestinal tract in human beings probably get into the liver through the lymphatics, and there (liver) in the interlobular tissue they produce these cyst like bodies which show two separate and distinct capsules an inner or brood capsule which as the name implies tends to reproduce the parasite and an outer or fibro elastic tissue capsule which is supplied by the organ in which the cyst is located. The hydatid grows at the expense of an organ, and strange as it may seem the organ seems to take kindly to the growing cyst. Such cells as are destroyed by the cyst are replaced elsewhere in the organ by a compensatory hypertrophy and unless the cysts are quite numerous and growth quite rapid there is little loss of function of the organ. The fibrous tissue capsule surrounding these cysts is seldom thick and is usually vascular so as to be able to furnish the cysts with nutrition.

The symptomatology of hydatids depends almost entirely upon the pressure effects exerted upon the organ. In the liver there may be an itching about the right shoulder, a sense of weight and distention. Actual pain is rare but if suppuration intervenes, as sometimes occurs in the liver excruciating pains in the liver region may exist. On the other hand not infrequently an autopsy may reveal a cyst of considerable size which gave no symptoms. The liver may enlarge and may extend below the costal arch and higher up into the thoracic cavity especially is this true in large deep-seated cysts. The rupture of a hydatid cyst of the liver is dangerous. The contents of the cyst may be squirted into the pleural cavity or peritoneal cavity depending of course upon the location of cyst.

**Treatment** So far as we know surgery is the only method of treating this condition. Wherever possible it is always best to remove the cyst *in toto* if this be impossible to remove as much of the cyst as possible and drain, and



Fig 1 (at left) Echinococcus cyst of the liver (human)

Fig 2 Echinococcus cyst of the liver (pig)

if this be impossible to aspirate the cyst. The whole question of treatment is well summed up in Albutt's *System of Medicine* in an article by Sterling and Verco

1. The objections to aspiratory puncture are that it is only applicable to a small class of cases that even in these it frequently fails in its object that it is in itself a possible source of danger by inducing suppurative changes or by permitting leakage of fluid with possible consequences that we have sufficiently indicated and that, at least it leaves the dead organism in place. In pulmonary hydatids there is a special risk of suffocative flooding.

2. Removal of the parasite by incision is an effectual and with proper care a reasonably safe proceeding it should be the general practice.

3. Lindemann's operation in which, after removal of the parasite, the activity of the adventitious sac is left to drain externally has stood the test of a large experience with favorable results and is probably the best and safest procedure for general application. Possibly however Bond's operation or some modification of it, in which, after evacuation, the emptied adventitious sac is left behind, may prove to be more satisfactory in certain cases.

#### CASES

**CASE 1:** Married woman age 48 entered Abingdon Hospital April 10 1915 complaining of a mass located in upper portion of right abdomen. Family history unimportant. Past history unimportant.

Present illness began about two years ago with dull pain in upper right abdomen. Some time after the pain began she noticed a small lump in the region in which the pain was located. This lump has grown steadily. At no time was the pain severe. She has never been jaundiced and seldom nauseated. She has lost considerable weight during the past two years and during the last three or four months she has been unable to attend to her household work. Examination was entirely negative except for a

mass about the size of a coconut lying in the right upper quadrant this mass was tender was movable with respiration was smooth or symmetrical and apparently was separate from the liver.

Urine negative. Blood examination negative.

Operation April 10 1915. The abdomen was opened by a high right rectus incision. On entering the abdominal cavity a large cyst attached to the under surface of the liver was seen, and several smaller cysts were found to be imbedded in the liver substance. The largest cyst (about the size of an orange) was enucleated without rupture. The liver was sutured with catgut to control the bleeding the other cysts were left. Wound closed with out drainage. Patient's postoperative course was uneventful and she was discharged from the hospital on the sixteenth day and has been well since.

Hooklets were found in the cyst fluid.

**CASE 2:** Married woman, age 62 entered Johnston Willis Sanatorium April 20 1914 complaining of epigastric pain. Past history unimportant.

Present illness began two years ago with a pain in right shoulder and a slight epigastric discomfort. There was some nausea and occasional vomiting attacks after meals. At no time was the pain severe. She has lost some weight. She has never been jaundiced and her bowels have moved with regularity. Physical examination, entirely negative except for a slight tenderness and a mass about the size of the fist in the epigastrium. Urine blood and stomach examinations negative.

Under other anesthesia April 25 1914 the abdomen was entered through a high right rectus incision. The liver was examined and found to contain a large number of cysts, ranging in size from an orange to a walnut and seemingly deep down in the liver substance. The aspirated fluid was clear and colorless. No scolices were found in the aspirated fluid. None of the cysts were removed and the wound was closed and drain was put at the site of the aspirated cyst. The patient's convalescence was satisfactory discharged from the hospital May 14 1914.



# DEPARTMENT OF TECHNIQUE

## THE KONDOLÉON OPERATION

### REPORT OF A CASE

From the Service of William B. Brannan, M.D., Long Island College Hospital

By ROBERT S. BARBER, M.D., B. LONKIN

**L**YMPHATIC obstruction from any cause produces dilatation of the lymph vessels, lymphangiectasis and results in oedema into the surrounding tissues. The resulting lymphoedema may cause great increase in size in the parts affected. In some cases the skin is unable to maintain its nutritional balance and areas of discharging ulcers or sinuses are formed. Depending upon the amount of discharge this last condition is known as lymphorrhea or lymphorrhagia. The composite picture occurs most frequently in the lower extremity and is known as elephantiasis.

In Kondoléon's seven reported cases four followed acute or chronic infections; the fifth resulted from total removal of the inguinal lymph nodes; the sixth was idiopathic; the seventh an arm case was a sequel of carcinoma of the breast previously operated upon with a recurrence in the axilla. Handley's cases were both secondary to carcinomata of the breast which had been operated upon. The case reported by Lanz was idiopathic. Other accepted causes of the condition are ulcers, tumors, scars or ligation of lymphatics. In cases due to malignancy Handley has shown that strands of carcinoma-cells first infiltrate the connective tissue, and then permeate the lymph-spaces which rupture producing an inflammatory reaction and fibrosis. It is the last process which produces the lymph stasis. The oedema is not due to compression of the vein because ligation of the vein in emergencies does not produce oedema. Arterial ligation as a curative operation is futile because it does not correct the pathological process.

The superficial lymphatics lie above the deep fascia and anastomose freely with each other. The deep lymphatics lie below the deep fascia, and these too have a free anastomosis. The superficial and the deep lymphatics anastomose with one another only through the lymph nodes.

Thus the deep fascia offers an absolute barrier between the superficial and the deep lymphatics. Upon this fact is based the principle of the surgical treatment of block.

Lanz and Hollander in 1911 published a new operation which he applied to a case of elephantiasis of the lower extremity. Through a long incision in the outer aspect of the thigh he split the fascia lata and trephined the femur in several places. He then inserted strips from the fascia into the openings in the bone. Fascia closed in part and wound closed without drainage. His case which was of four years standing made a complete recovery.

Handley an Englishman in 1908 reported two cases of lymphatic block of the upper extremity which he treated successfully by insertion of strands of silk in the subcutaneous tissues from the wrist to the uninvolved skin of the axilla. He obtained good results as far as the oedema was concerned.

Kondoléon a Greek surgeon giving due credit to these pioneers for the underlying principles of treatment which they had pointed out, in 1912 published an operation which he had done successfully in seven cases. The operation has since borne his name. By his studies and experiments he showed that the lymphoedema was limited by the deep fascia below and the skin above. He made two incisions (or four if the thigh were also involved) on the inner and outer side of the extremity several inches long down to the deep fascia. Redundant edematous fat and superficial fascia he excised in part. A strip of the deep fascia three to four fingers in width was then removed from the underlying muscles. All hemorrhage was thoroughly stopped by ligatures and the skin closed without drainage. The results of the operation were uniformly good. In his first case he had to repeat the operation twice, because his fascial excisions were not sufficiently extensive. In one of his earlier operations

he twisted the elevated band of deep fascia into a cord and tucked it into the deep muscles leaving the upper end of the fascial strip attached.

Dean Lewis of Chicago has done the operation once in an unreported case. He obtained a perfectly satisfactory result.

#### AUTHOR'S CASE

D. G. male 34 years old a laborer. Past history negative. Present history: On July 2, 1914 he received a punctured wound of the left index finger. On the following day the finger was painful and swollen with swelling beginning to extend up the forearm. There was crepitation in the hand and wrist due to some gas-forming organism. On July 9, 1914 multiple incisions were made in the hand and wrist. The wounds healed and the patient returned to work in the capacity of a watchman for one year. On June 8, 1915 the man was returned to his original task of hard manual labor with pick and shovel. On June 10 the left hand and forearm were greatly swollen although there were no signs of infection and very little pain. The left forearm was brawny and hard and 1 1/2 times the size of the right.

Operation, August 1, 1915. Incision 5 inches long along inner aspect of left forearm. Fascia exposed and 5 inches of fascia two fingers in width removed, wound closed without drainage. The result of the operation was improvement but not complete relief. Use of the arm caused the swelling to return. He returned to hospital on October 1, 1915 and was operated upon again. An operation similar to the first was done on the outer aspect of the forearm. Primary union resulted. Three weeks after this operation the forearm was the same as the right

in size and consistency. Reports from the patient's physician six months after the operation show a satisfactory result with no return of the edema. The forearms are of equal size. There is no disability.

#### CONCLUSION

Experimental work by Opie has shown that the coagulation time of lymph is from ten to twenty minutes of blood four to six minutes. This fact alone probably accounts for the relative infrequency of lymphatic thrombosis as compared with hæmic thrombosis. Transient oedema disappears in two to four days either by new channels or by collateral lymphatics. Lymphoedema lasting for several weeks after the disappearance of the inflammatory process which produced it is due to lymphatic block and is probably permanent. The Kondoleon operation offers a means of relief which is not obtainable by any other method.

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## THE DIAGNOSIS AND TREATMENT OF TUMORS OF THE URINARY BLADDER<sup>1</sup>

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IT is not our purpose at this time to discuss the etiology and pathology of vesical neoplasms but to set forth in as concise and comprehensive a manner as possible the essentials of the symptoms, diagnosis and treatment of these growths.

#### SYMPTOMS

The cardinal symptom is hæmaturia, intermittent or constant. According to Keys the first, last, and often the only symptom of tumor of the bladder is hæmorrhage. The characteristic hæmorrhage of a neoplasm, whether renal or vesical, begins without warning, continues copious and painless unaffected by rest, diet or medication, and ceases as it began, without apparent

reason. Its cessation may leave the urine normal and the patient lulled into a false sense of security by what he considers his escape from a serious condition. Pain and dysuria usually appear some days, weeks or months after the first hæmorrhage. Exceptionally pain and dysuria precede the hæmorrhage. This is alleged to occur most frequently in sarcoma. Sharp lancinating pains also arise spontaneously from malignant growths.

At times the symptoms may suggest vesical calculus, especially in children with pain referred to the glans penis.

McCarthy<sup>2</sup> describes the symptomatology as follows: An idiopathic intermittent hæmaturia

McCarthy. *Tr. Am. Urol. Ass.*, 9

usually total rarely when the growth is located in the region of the vesical neck, the blood will be more pronounced at the end of urination. This hæmaturia is capricious entirely independent of external causes. In fact it is frequently more marked when the patient is resting quietly in bed, disappearing and reappearing without discernible cause. Thompson has called attention to dysuria as indicative of malignancy. Hæmaturia in the presence of a sessile or an infiltrating growth, associated with bullous oedema is absolutely pathognomonic of malignancy.

In view of these facts the presence of blood in the urine should be considered an alarming symptom and when one realizes that every case of vesical tumor is potential of malignancy it would seem that, as suggested by Kelley in the best interests of the patient every case of undetermined hæmaturia should be referred to the specialist for early diagnosis and treatment.

#### DIAGNOSIS

Usually the best method of determining the presence and characteristics of a bladder tumor is with the cystoscope. In fact it is in the diagnosis of vesical tumor that cystoscopy has attained its greatest triumph. With the cystoscope one usually can readily determine the location size shape whether or not the tumor is villous or nodular pedunculated or sessile, diffuse or circumscribed.

In using the cystoscope in an attempt to discover the existence of a vesical tumor one should observe the bladder while fully distended, and also during the process of filling and emptying as in this way small buds may be discovered which might be otherwise overlooked. This is especially true in cases of recurrence.

As it is impossible within the limits of this paper to discuss the differential diagnosis of vesical tumors from a pathological and histological standpoint it would seem expedient to refer those interested to the excellent symposium on this subject by Buerger.<sup>1</sup>

From a clinical and therapeutic standpoint tumors of the bladder may be classified as benign and malignant. Representative of these two groups are respectively the papillomata and the carcinomata.

**Papilloma.** As ordinarily used this term designates a benign tumor either single or multiple, sessile or pedunculated, having a surface made up of branching arms, terminating in fingerlike projections, or villi, composed of a central connective-tissue stem or axis, accom-

panied by a loop of blood-vessels and covered externally by one or more layers of epithelium.

**Carcinoma.** These are usually broad based, hard sessile tumors likely to be not freely movable but in individual cases may resemble a benign papilloma. In many cases the macroscopical appearance of these two forms of vesical tumor may be so closely allied that the tumor tissue must be submitted to the pathologist and the microscope before a differential diagnosis can be made with certainty. For this reason, only early and accurate diagnosis and radical treatment can best subserve the interests of the patient.

In a bladder more or less choked with a papillomatous tumor much useful information can be gained by the use of the X ray. This is accomplished by injecting the bladder with a sufficient amount of thorium to distend the bladder but not to overshadow the growth. An X ray picture of this kind shows the available space not occupied by the tumor and in some cases which, with the cystoscope appear to be inoperable it can be seen that the tumor is a large villous mass with a small pedicle and can be readily removed by surgical interference.

#### TREATMENT

The treatment of every case of vesical tumor is by eradication at the earliest possible moment. The simplest benign papillomata, tend to transformation into malignancy.

According to Schmidt,<sup>2</sup> if the growth is permitted to continue hæmorrhage and sepsis and the results of backward pressure and infection, that is pyelonephritis occur. To permit such to occur at the present time should be nothing less than a crime.

In order to properly select an appropriate and efficient mode of attack, in a given case of vesical tumor one must necessarily have decided that a tumor is to be dealt with the number situation, type of implantation, and the degree of development of the neoplasm at the time treatment is instituted. The treatment of every case of vesical tumor except in a certain percentage of late carcinomata is essentially surgical.

At this time we shall consider only two principal modes of attack namely transurethral electrothermic coagulation, and transvesical section. In certain selected cases a combination of both may be advisable. Both of these methods should be augmented, in all cases of suspected or known malignancy by massive roentgen therapy or radium, or both.

*Transurethral electrothermic coagulation* or desiccation, of vesical tumors consists of the application of the high frequency current to the tumor by means of an insulated wire introduced through the cystoscope. The method was introduced by Edwin Beer.<sup>1</sup> He employed the monopolar or Oudin current in essentially the same manner as used at present. The same year the bipolar or d Arsonval current, was used by Keys,<sup>2</sup> but subsequently abandoned in favor of the Oudin current.

While both methods are employed at the present time the Oudin current seems to be the one of choice by most operators. The effect of the monopolar current, is a relatively superficial coagulation while that of the bipolar is a deep baking process, capable if used in sufficient strength, to cause the destruction to almost any extent of the tissue involved. While it is conceded to have its advantages in certain selected conditions it can be readily understood to be a dangerous procedure, in the hands of any except the most experienced surgeon especially so if applied in proximity to the peritoneum. Some operators hope by the use of this current to destroy the carcinomatous base of a papillomatous tumor and that this can be accomplished is illustrated by the following case

**CASE 1** Miss H. age 55 Present trouble began in January 1916 At this time patient noticed blood with the urine. This rapidly became more pronounced, and was soon accompanied by considerable pain, especially at the end of urination. On June 18th patient appeared at office for examination. Cystoscopic examination revealed a rather large villous tumor situated just above the left ureter. Tissue removed showed the growth to be a papillomatous carcinoma. At this time patient was passing a large amount of blood, accompanied by much pain on urination. The Oudin current was applied at intervals of three to eight days. The tumor rapidly decreased in size, although some rather alarming hemorrhages occurred between sittings. The treatments continued over a period of ten weeks. As soon as the base of the tumor was reached, the d Arsonval current was applied. This was used twice followed by one sitting with the Oudin current. On September 18th, cystoscopic examination showed the tumor entirely disappeared the area of the base occupied by contracted scar tissue.

As to what cases are suitable for high frequency treatment is a topic for much discussion and wide variance of opinion. That it is the method of choice in all cases of benign papilloma, of moderate involvement is pretty generally accepted. That it is contra indicated in most cases of clinical malignancy is equally well known. Opinion as to what degree of malignancy constitutes a contra indication varies with the

individual operator. However in the presence of hard, sessile tumors intractable cystitis, sloughing or ulcerated tumors great multiplicity, or tumors of great size the high frequency method alone may be well said to be contra indicated.

The principal factor in favor of the use of the high frequency current, is the minimum discomfort and inconvenience to the patient. By this method a radical course of treatment can be applied in the office. The patient readily accepts the treatment as he is able to pursue his regular duties without inconvenience or loss of time.

Another factor in favor of the use of the high frequency method of treatment is the ease with which recurrences can be handled. In every case of vesical tumor the patient should appear for frequent postoperative cystoscopic examination. And when recurrences in the form of small buds are discovered, they can be at once attacked and subdued by this mode of treatment.

The high frequency current is also a potent factor in the control of hemorrhage in vesical tumor. Alarming hemorrhage may occur at any time. This sometimes follows treatment when the burned area separates from the tumor. In cases of this sort, the proper procedure is more of the same treatment in the same place. In this connection it is well to state that in cases where the patient becomes anemic from loss of blood an excellent procedure is to perform a transfusion.

*Technique of the application of the high frequency current* As previously stated transurethral electrothermic coagulation is applied through the cystoscope. The cystoscopic technique in the application of the high frequency current, is essentially the same as used in ureteral catheterization. As recommended by Thomas<sup>3</sup> a double catheterizing cystoscope should be used, and an insulated wire cable introduced through each catheter channel. In this way, when a wire becomes blunted or welded as frequently happens before a treatment is completed it can be abandoned and the sitting completed without withdrawing the cystoscope.

As to the manner of applying the electrode to the growth some difference of opinion exists. While some operators recommend the application of the electrode directly to the pedicle of the tumor, it should be considered a more or less dangerous procedure as a routine measure. Its only advantage would seem to be a shortening of the course of treatment, and in most cases where it is possible to make use of the high frequency method haste is not a compelling factor.

As a general routine the safest and most efficient plan is to apply the electrode to the periphery of the tumor and advance toward the base at each sitting as rapidly as the separation of the previously coagulated tissue will permit. In approaching the base of the tumor one should use care and not burn too much tissue at one sitting as deep desiccation of the bladder wall may be followed by perforation.

The frequency of the sittings must be governed by the tolerance of the individual patient and the character of the tumor. If the patient be tolerant or the tumor of the large villous type frequent sittings may be practiced. With a large villous tumor a good plan is to burn a different area at each sitting with short intervals between each treatment. As a usual thing in all cases the treatment should be pushed as rapidly as the burned tissue separates. This usually occurs in about three to eight days and this should be about the time between treatment.

In regard to the care of the patient between sittings the sloughing tissue must be considered a foreign body and an excellent culture medium for bacteria. For this reason frequent lavage of the bladder with antiseptic solutions is to be recommended.

During the course of treatment the patient should be constantly within reach of the surgeon as alarming hemorrhage may appear before stated and requires prompt attention.

As to the time required for the removal of a vesical tumor by the application of the high frequency current no definite estimate can be given. Suffice to say however that most papilloma especially of the benign type are readily removed within a few weeks by this method of treatment.

Should the growth not materially decrease in size after a reasonable number of treatments it should be considered clinically malignant and beyond benefit by this method and it should be immediately attacked by transvesical section.

That the high-frequency current is a most practical and successful method of treating a variety of vesical tumors is evidenced by a report of the following cases:

CASE 1. M. S. age 45. Family history important. Previous history negative. Present trouble began in July 1901 when he began to have hematuria at attack of severe hematuria. His condition became progressively worse and December 5, 1901 this patient was passing enormous quantities of blood and had lost control of the vesical sphincter. The patient was very weak and anemic and had hemoglobin of 54. Cystoscopic examination showed the bladder filled with multiple villous tumors, which proved to be papillomatous carcinomata. On

January 6, 1902 the growths were removed by suprapubic transvesical section. The patient's symptoms rapidly cleared and he made an uneventful recovery. One year later tumors again appeared, and were again removed in the same manner except that the bases of the growths were fulgurated. He was referred to Dr. Skinner who gave him deep X-ray therapy. Recent cystoscopic examination and X-ray picture taken with thorium in the bladder shows normal capacity and no recurrences.

CASE 2. M. H. age 50. Denies venereal infection. Present trouble began in July, 1903. Patient first experienced distress in the suprapubic region, accompanied by frequent and painful micturition. He soon began to pass small catull with considerable terminal hematuria. On September 5, 1903 cystoscopic examination showed a fairly large hard sessile nodulated tumor situated near the base of the trigone and covered with incrustation. Tumor still decreased in size under high-frequency treatment and entirely disappeared within five weeks. No recurrence.

CASE 3. Mrs. B. age 41 married. Present trouble began December 1905. At this time the patient first noticed blood in the urine. This was soon followed by the constant passage of blood from the urethra, during the intervals between micturition. Suprapubic distress was constant and pain on urination as very severe. Her condition rapidly grew worse, and January 1, 1906 some sort of growth was removed from the upper urethra. The patient improved somewhat but the pain and hemorrhage continued. On March 5, 1906 she applied to this office for treatment. Cystoscopic examination showed a clot of small papillomatous growths surrounding the external phincter and the lower urethra. Under ether anesthesia, deep fulguration as applied to the growths. The patient improved somewhat but the pain and hemorrhage did not entirely disappear. On May 5, 1906 she again entered the hospital and deep fulguration was applied to the remaining parts of the growths. The present condition rapidly cleared up. Frequent cystoscopic examination shows no recurrence.

CASE 4. M. O. age 37. Family and previous history exact. Present trouble began March, 1905. First noticed but he thought as small amount of blood passing with the urine. This rapidly increased in volume, complicated by marked terminal hematuria. He also began to pass some clotted blood as his condition became more serious. Patient had no pain at any time. On June 5, 1905 cystoscopic examination showed a medium sized villous tumor just below the left ureter. Under fulguration treatment the patient's symptoms rapidly disappeared and he was discharged August 5th with no evidence of the growth. Small recurrence appeared one month later. After treatment but disappeared.

CASE 5. Mrs. S. age 50, married. Present trouble began January 1907. First began to be troubled with frequency of urination accompanied by considerable distress. Her symptoms increased in severity and in October the patient was compelled to take to her bed. About this time she noticed blood passing with the urine for the first time. She was then voiding blood every 15 to fifteen minutes. On January 5, 1907 cystoscopic examination showed large rather elongated villous tumor located back of the left ureter. Patient received fifteen fulguration treatments. Tumor entirely disappeared, together with all symptoms. In June 1906 a small recurrence as discovered, which yielded to treatment in three sittings. On November 1907, cystoscopic examination showed bladder clear of all growths. A small villous tumor was discovered at the external meatus. This was incised and the base cauterized.

*Transvesical section* At this time a question exists as to whether or not the bladder should be opened in all cases of vesical tumor not amenable to fulguration. The excellent results reported by Pfahler of Philadelphia and others by the use of massive roentgentherapy in carcinoma located in other parts of the body and the encouraging report of cases treated by Barringer of New York with radium in inoperable vesical carcinoma demand consideration.

Whether or not massive roentgentherapy or the use of radium shall be given precedence over resection of malignant growths located in the trigone or extensively involving other parts of the bladder experience must decide.

Of the several routes of entering the bladder in vogue at one time or another all except the suprapubic have been discarded as obsolete by most operators. When opening the bladder suprapubically for the purpose of resecting a vesical tumor the question naturally arises as to whether or not the peritoneal cavity must be entered. In practically all cases demanding cystotomy for tumor infection is present and while numerous cases are on record where the bladder contents have entered the peritoneal cavity without untoward results extraperitoneal section is to be preferred whenever possible. However in cases of extensive involvement of the superior and posterior walls of the bladder in cases where the peritoneum cannot be readily stripped off it is advisable to boldly enter the peritoneal cavity and resect such portion of the vesical wall as may be necessary for the removal of the growth. Before attempting to strip off the peritoneum the urachus should be divided and the cut ends cauterized as this rudimentary organ is some times patent and may be a possible inhabitant of infective organisms.

Before being opened, the bladder should be cleansed with some antiseptic solution and filled with air. The air is preferable to fluid distention as only the urine secreted during the operation has to be cared for and the possibility of infective fluid entering the prevesical space or the peritoneal cavity is greatly lessened.

All tumors of the bladder are prone to recur. A marked tendency exists for recurrences to appear at the sites of incisions. Keys has recommended stitching the bladder walls to the skin after opening before interfering with the tumor. After the bladder has been exposed, the operator must select the technique which seems indicated by the character of his findings having already informed himself as to the nature and extent of the involvement.

Small pedunculated non-infiltrating tumors can be readily grasped and separated from the pedicle and the base and a few centimeters of the adjacent bladder wall fulgurated or the base and pedicle can be removed with the cautery knife. Great care should be exercised in removing the tumor to see that it does not come in contact with the edges of the wound. In dealing with a large papilloma it may be almost impossible to extract the tumor from the bladder without coming in contact with the edges of the suprapubic wound. For this reason it is well to cauterize all wound edges before closing.

A tumor with a hard infiltrating base demands wide resection of the entire bladder wall. Beer has described an excellent technique in these cases by entirely stripping the peritoneum from the bladder and incising the wall about the tumor from without inward. The resection should best be done with the cautery knife whenever possible. The wound should be closed by catgut sutures internally and reinforced with silk or linen externally.

When the tumor is located near or involves the ureteral orifice it will be necessary to resect and implant the ureter. Catheterizing the ureter before commencing the resection greatly facilitates the work.

As implantations on wound edges are common and as one cannot be certain that this has not occurred during the operation some method of prevention should be employed. For this reason the cautery knife should be used for resection whenever possible and all wound edges should be cauterized before closing. Burnam of Baltimore has suggested flushing the bladder with alcohol before closing.

# CONCLUSIONS

- 1 That every patient suffering from hæmatoma should be referred to the urologist for an early diagnosis.
- 2 That, when found to be present, all vesicle tumors should be eradicated.
- 3 That all cases of untreated vesicle tumor terminate fatally.
- 4 Method of choice. That all tumors of the bladder whether benign or malignant, pedunculated or sessile should be subjected to the high frequency current.
- 5 That all tumors not amenable to the high frequency current should be removed by transvesical section.
- 6 That massive roentgentherapy and possibly radium should be combined with high frequency and transvesical section.

## CONGENITAL RECTOVAGINAL FISTULA

## A NEW OPERATION FOR ITS CURE

CARYL A. POTTER, M.D. ST. JOSEPH, MISSOURI

**A**NOMALIES causing incontinence of feces or any impairment of the normal function of the rectum are held in abhorrence by the laity and the medical profession dreads above all things fecal fistula whether they are inevitable postoperative sequences or purposely made by the surgeon. Consider then the discomfort and mortification which would come to a woman with a congenital rectovaginal fistula who had only known fecal incontinence since birth. Such a patient was the following

S. L., age 16 was referred to me with the following history. Since birth nothing had passed through the external anal orifice but there had been a constant leakage of fecal matter through the vagina. She had constantly worn a pad to keep from soiling her clothes.

Every precaution was necessary to prevent her body from emitting a fecal odor and constant changing and care were necessary if she allowed herself the company of other people. After she commenced to menstruate the mixture of fecal matter and menstrual fluid made the condition more abhorrent and when I saw her she was not only a cure to herself but a cure to those about her. She had been "rained" on several occasions but had been given little encouragement for relief.

A cursory examination only partly revealed the existing condition. In order to elucidate the true character of the malformation an ether examination was advised with the possibility of a concurrent operation. The existing condition is shown in Figure

The strength of the external sphincter and which guarded the external orifice of the anal canal was especially noticeable.

After thorough examination I satiated myself with dilatation of the rudimentary anus and rectum but it tempted no operation. Before the patient returned home she was given dose of castor oil the vaginal outlet plugged and, when she felt inclined to a bowel movement, instructed to strain. She noticed a small amount of fecal matter pass from the rudimentary anus under control. She was sent home and instructed to close the vaginal outlet with gauze instead of wearing pad and to take plenty of liquid, alboline, prunes, and figs to see if the rudimentary anus would prove serviceable. She wrote that the dilatation had helped considerably but suggested that some sort of an apparatus could possibly be made to close the vaginal outlet. I was considering the construction of one when she wrote again saying that the rudimentary rectum and anus were not functioning so well as formerly and she suggested that she return for another dilatation. It was proposed that she return for an operation which might result in permanent or partial cure. A plan I had in mind at the time was an operation to close the vagina entirely and plastic operation to the rectovaginal opening and rudimentary anus, thus obliterating the vaginal outlet and giving her a common cloaca, similar to that of early embryonic and lower animal life. This would result in common outlet through

the rudimentary rectum and anus which would allow fecal matter and vaginal and uterine secretions to make exit through a common opening. As this would be controlled by the sphincter ani, it would be much preferable to a constant leakage through the vaginal outlet. On further consideration and study of the condition, it seemed not only possible but probable that an operation could be performed which would result in a separate vagina and rectum.

Investigation of the literature was futile. There is little if any mention of the condition, much less a description of its operative cure. A brief study of the embryology is interesting and explains the existing anomaly. According to Hensler

The early stages in the development of the anus are similar to those of the mouth. The so-called anal membrane is produced by the growing together of the ectoderm and endoderm, the mesoderm being crowded aside. The side of the anal membrane, or anal plate, is in the median line of the dorsal surface of the embryonic body at its posterior or caudal extremity. It makes its appearance the third week. Since the tissue immediately in front, i.e., headward of the anal plate projects and develops into the primitive tail and since the axis of the body becomes ventrally curved, the anal plate is carried around somewhat toward the ventral aspect of the body. During the following fortnight the anal plate becomes depressed so as to form a small fossa which is designated the anal pit or proctoderm. The anal plate, in position, does not correspond in vertebrates, to the end of the intestine but to a point short of it. The gut, therefore, extends beyond the position of the anus. This portion of the bowel is the post-anal gut of vertebrate morphology. Ultimately it entirely disappears.

While the anal pit is forming the allantois is growing forth as a diverticulum from the ventral wall of gut.

The intra-embryonic part of the allantois is transformed chiefly into urinary bladder but from its proximal extremity it gives rise to a short wide duct, the urogenital sinus, which is the venue of communication with bowel. The surface depression referred to above as the anal pit is often called the cloacal depression, while a cloaca is present.

In the lower mammals and monotremes, as also in amphibia, reptiles, and birds, the cloaca is a permanent structure. By breaking down of this membrane between it and the cloacal depression it acquires an outlet through which urine, feces, and genital products find egress. In all higher mammals, however, including man, the cloaca suffers division into an anterior or ventral passage-way, the urogenital sinus, and posterior canal, the rectum and canal of the anus. This division is effected by the growth of three ridges or folds of which one grows from the point of union of the urogenital sinus and the gut, while the other two proceed, one from each lateral wall of the cloaca. The three folds coalesce to form perfect septum. The division is complete about the end of the second month.

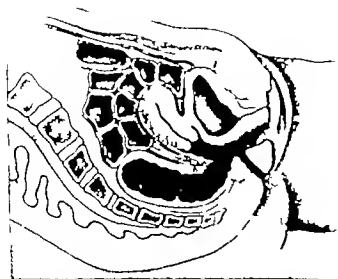


Fig 1 Congenital rectovaginal fistula. 1 Anterior flap of the split rectovaginal septum which formed part of the new vaginal floor. B posterior flap of the split rectovaginal septum which formed the new anterior wall of the rectum. X mount of tissue removed by diamond shaped incision indicated by dotted line. On being sewed longitudinally this helped to flatten out and form the new posterior rectal wall. Y Perineal body Rudimentary anus is shown between X and Y. Dotted line between A and B indicates the line of incision to form the flaps for the posterior vaginal and anterior rectal walls.

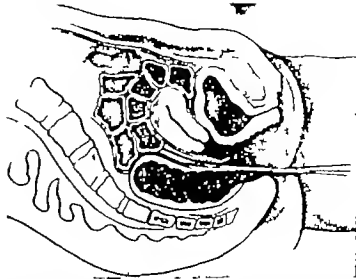


Fig 2 This shows the rudimentary anus and vagina made a common opening by having split the perineal body the posterior mound of tissue removed to flatten out the rectum and the posterior flap B of the split rectovaginal septum pulled forward to the sphincter to form the lumen for a new anal canal and rectum.

The following operation for the cure of the condition was planned and executed

The cloacal depression or anal pit shares in this division so that about the tenth week it is separated into the anal pit proper or proctoderm, and the orifice of the urogenital sinus. The newly-formed septum continues to thicken, especially near the surface of the body until it constitutes the pyramidal mass of tissue known as the perineal body or perineum.

The anal pit deepens the anal membrane being thereby approximated to the end of the bowel, and in the fourth month the anal membrane breaks down and disappears. Persistence of the anal membrane after birth constitutes the anomaly known as imperforate anus.

The explanation of the formation of the condition shown in Figure 1 (congenital rectovaginal fistula) is readily seen from the embryological description above. The failure of the three ridges or folds to coalesce and form a perfect septum is responsible for a part of the condition.

Any one of these failing to grow across and meet the other would cause the defect, just as the failure of the anal membrane to break through would cause imperforate anus. Another look at the figure will explain the true condition of affairs. The urogenital fold has grown downward incompletely and the lateral folds have not entirely closed. The lower end of the septum has thickened to form a perfect perineum and the cloacal or anal pit growing in from the posterior end has formed a fairly good anus. It is therefore, a defect due to failure of closure of the three ridges principally the two lateral ones

With a curved bistoury slipped entirely through the rudimentary anus and rectum into the vagina the anterior wall of the rudimentary anus and rectum (including the external sphincter and poorly developed internal sphincter) and the perineal body were split, thus making the rudimentary anus and vagina a common opening, the cut perineal body intervening between the mucous membranes of the rectum and the mucous membrane of the vagina. The split ends of the levator ani muscle and fascia were located and dissected free for future use. With a razor blade knife the anterior layer of rectovaginal septum was separated from the posterior layer three-fourths of the distance to the cul-de-sac, giving an elastic membrane covered with vaginal mucous membrane anteriorly and another, covered with rectal mucous membrane, posteriorly. A diamond-shaped piece was taken out of the mound in the posterior rectal wall and longitudinal interrupted sutures of chromic 30 day No. 1 catgut placed so as to lengthen as well as to flatten the posterior surface in order to form the posterior wall of the new rectum and anus. On the posterior half of the split rectovaginal septum, i.e. the anterior wall of the true rectum, three Ochsner forceps were placed and drawn down by an assistant so that the anterior rectal wall would meet the cut ends of the sphincter ani. Not wishing to place too much tension on the anterior or vaginal half of the split septum two flaps with broad bases were dissected free from the lateral vaginal walls, so that on rotation they could be coapted to the anterior or vaginal side of the split septum. These procedures are shown clearly in Figures 1 and 2.

With the assistant holding the posterior half of septum taut, sutures were passed through the levator ani muscle, fascia and septum. Additional interrupted sutures were placed through the levator alone to relieve tension on the sutures placed through muscles and septum. The lateral margins of the posterior layer of the septum were sutured to the rectal wall thus completing the new rectal lumen.





Fig. 3

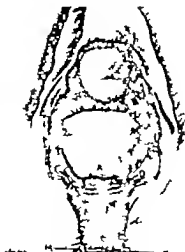


Fig. 4

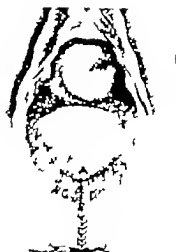


Fig. 5

Fig. 3. The clamps have been placed on the posterior half of the split recto-anal septum preparatory to drawing it forward (line *A*); the anterior half of the recto-anal septum remains (*A*) free, and flaps *C* and *D* have been dissected from the lateral anal walls (*B*) being rotated and sutured to (*A*) they help form the anal floor.

Fig. 4. The levators are shown dissected (*A*). *S* turns have been placed through the levators and connective tissue of the new anterior rectal wall (*B*) which has been drawn forward and sutured to the mucous membrane of the old rudimentary anus (*C*) drawing tight and tying these sutures dead space killed and new pelvic floor

formed. *M* and *N* indicate the cut ends of the sphincter.

Fig. 5. Shows the completed operation. *C* and *D* have been rotated and sutured to (*A*) form the front portion of the new anal floor. The mucous membrane proximal to the (*A*) and bounding the raw surface left by the rotated flaps has been dissected back and sutured to (*A*). The skin has been dissected back and is shown sutured to (*A*) to form the skin of the new perineum. The line *S* indicates the cut end of the sphincter and which have been dissected free and sutured to the skin edge allowing temporary incontinence but readily accessible for future union under local anesthesia.

Both the muscle sutures and the muscle and septum sutures were simultaneously drawn tight and new pelvic floor formed. The purpose in placing the sutures through muscle and septum was to distribute the tension over a wider area and kill dead space by making the new anterior rectal wall hug the perineal body closely, killing dead space in rectal fold (successful plastic anal fold). The foregoing steps are shown in Figure 3.

The next step was the rotation of the lateral anal flaps and the closure of the skin. These steps are shown in Figure 4.

Although everything was sewed solid, it was felt that the whole procedure would probably be fruitful if tension were allowed to be made on the sutures. At the same time, were after ultimate rectal control. As I mentioned before, the sphincter and muscle was very strong but had it in the original procedure. It was decided that more perfect solid union of the newly made structures would result if we gave the patient temporary incontinence. Therefore the external sphincter was left divided but the ends dissected free and stitched to the skin so as to be readily accessible for later union under local anesthetic.

Following operation the bowel was not moved for six days. On the sixth night 4 ounces of olive oil

injected into the rectum, the walls of which were apparently intact. Castor oil given and in the morning the bowels moved. 6 ounces of olive oil injected into the rectum. The pads were solid with fecal matter the morning of the seventh day. The field of operation was not examined until the eighth day when the silk permanent sutures through the skin were removed. The pelvic floor intact and the new rectum and vagina were of sufficient size.

The patient was kept in bed three and one-half weeks and discharged from the hospital at the end of four weeks.

During this time several ounces of olive oil were injected into the rectum the morning of each alternate day. She was discharged at the end of the fourth week and instructed to return four months so that the cut ends of the external sphincter could be united. I waited five months and then wrote her urging her to return. She replied that it was unnecessary to return as she could control her bowel movement altogether except when she took castor oil, and then there was only slight leakage of liquid fecal matter. Recent examination showed that the slight bridge which had been left between the cut ends of the external sphincter had been spanned by fibrous tissue. The sphincter control is good.





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## OBSERVATIONS ON GAS-BACILLUS INFECTION IN FRANCE

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THE following observations were gained from a personal experience of more than a year's work among the French wounded combined with opportunities for noting the ideas and methods of French surgeons. Of all the classes of wound seen in the present European war the most terrible and formidable are those of the so-called gas-bacillus infection. This infection well known in former wars and but little known in times of peace has played an important part in the mortality of the present warfare. The protean aspects of gas bacillus infection may be noted by the fact that in medical literature it is designated by at least thirteen different names according as the authors have been impressed by different symptoms and by the rapidity and gravity of their evolution. The term gas-bacillus infection is used in this article as it is the expression commonly employed by American surgeons in France the term gas gangrene being manifestly unsuitable. The French employ the designation *l'infection gazeuse* or *l'infection gaseuse*. A translation of the latter term as gas-producing infection may be accepted as more expressive than the term gas bacillus infection in general use.

Out of the maze of complicating ideas as to etiology, symptomatology, clinical divisions and methods of treatment have evolved definite conclusions which are of permanent value and which should prove their value in

case our soldiers should become involved in the grim realities of war.

Statistics as to the number of cases treated and the mortality are not available as the official records have not been made public. Records of individual surgeons or hospitals vary considerably depending on different factors such as the location of the hospital, the character of the wounds received and the period of time that has elapsed between the receipt of the wound and admission to the hospital.

### ETIOLOGY

The following factors will be considered

- 1 Soil
- 2 Weather
- 3 Clothing
- 4 Skin
- 5 Projectile
- 6 Character of wound
- 7 Flora of wound

1. The soil of France has been cultivated and fertilized for centuries and germs of many kinds and particularly spores are to be found in great quantities. The conditions are very different from what existed say in South Africa in the Boer War where to a large extent the battle grounds were uninhabited country. In the Boer War few surgeons saw gas gangrene. In this war few or none have escaped seeing it. The infection is considered by some to be more prone to develop in certain zones than others. Thus the wounded

from the cultivated Champagne region show perhaps a higher percentage of gas bacillus infection than wounded from the mountainous Vosges. Such important other factors as the season and the congestion of wounded enter into consideration so that in the absence of further data the influence of the soil of a particular region should not be given too much prominence. The present method of trench warfare contrasts markedly with that of former wars. Extensive movement of troops and open fighting when troops marched out as on a parade is no more and the soldier now lives in constant intimacy with the soil. Life in the trenches is not conducive to cleanliness and the earth which protects the soldier and his clothing and penetrates every pore of his skin. The large number of men living in such a restrained area for months adds to the contamination of the soil already existing. The construction of the trenches necessitates corners and recesses where the sun does not penetrate and where the growth of bacteria is favored. In spite of precautions fecal matter is transplanted by the feet and contaminates the bottom of the trenches.

2 There are said to be about 150 rainy days in the year in northern France. The rain brings about a condition of mud almost inconceivable. The narrow deep trench is not favorable to evaporation and the great numbers of men crowded together add to the process of mud making. Bad weather not only causes mud but wets the soldier's muddy uniform so that the dirt is diffused through the cloth. In warm weather dust, a very persistent, permeates the clothing and combined with perspiration creates a favorable condition for germ development.

3 The French uniform is made of a heavy kind of felt. The soldier wears his overcoat almost always even on the hottest days. The clothing moist from rain or perspiration, and more or less dirty, offers an excellent habitat for bacteria and probably the majority of gas infections originate from the piece of cloth that is carried into the wound. Fleming in an examination of soldiers' uniforms reports having found bacillus perfringens in 83 per cent bacilli tetanus in

33 per cent streptococci in 41 per cent, and staphylococci in 1, per cent.

4 The period of time for a soldier to be on duty in the first line varies in different regions and at different times. In times of relative calm provision can be made for the soldier's bodily cleanliness. In times of stress no such provision can be taken advantage of and it is not uncommon for a wounded man on admission to the hospital to have his clothes removed for the first time in two or three weeks. Owing to the lack of opportunities for cleanliness there is usually fecal contamination of the buttock and thighs. The duration of time on the battle field should be mentioned. While in favorable circumstances the majority of the wounded are able to have their first aid dressing applied at once, yet it is not uncommon for a wounded man to lie on the field for hours before receiving attention.

The projectiles pieces of shells bombs, grenades and shrapnel cause gas infection particularly because of pieces of clothing, dirt bits of stone pebbles and even straw and pieces of wood which are carried into the wound. The rifle ball fired from a distance and entering the tissues by its point creates usually an aseptic wound. The rifle ball deflected or fired at close range creates a wound liable to infection. The pieces of shell are the worst offenders in that they carry in pieces of clothing into the depths of the wound their rough edges tearing the cloth and causing the piece of cloth to adhere to it. It is not uncommon to find a piece of shell in the depths of the wound with a piece of cloth wrapped around it. A large piece of shell is apt to carry into the wound a large piece of cloth and a similar condition is produced by a large number of smaller projectiles.

6 When the contaminated foreign body is carried into the depths of the wound and remains there infection is much more apt to develop than when the wound is through-and-through. The rarity of gas infection in civil life among accidents in the same agricultural area may be largely explained by the fact that the agent causing the wound does not as a rule remain in the wound. Multiple

wounds comminution of bone extensive laceration of soft parts are lesions exposed mostly to infection. The lacerated infiltrated and devitalized muscles are the favorite starting place for gas gangrene. A cavity filled with clots with muscular débris in process of autolysis presents an admirable culture medium for the bacteria carried therein.

Lack of oxygen supply of the blood favors the development of the anaerobic bacteria. Restriction of the blood supply by the pressure of a hematoma by a tourniquet or by the ligation of a large vessel favor the development of infection by the lack of oxygen. Lack of oxygen supply from the air acts in a similar manner. A piece of shell is apt to make a small wound of entrance and then cause extensive injury to the deeper tissues. A deep wound a wound closed over too quickly either spontaneously or by misjudged surgery may produce a condition favoring the production of anaerobic infection in that the access of oxygen is excluded.

7. There exists considerable confusion in the classification of the anaerobic flora found in gas infections. No specific bacillus is recognized as the cause many varieties have been found and new anaerobes have been described. Which organism plays the most important part has not been decided. Attempts to limit certain clinical forms of the infection to certain species of infecting organism have added to the confusion. In France from a practical standpoint, the bacillus perfringens is usually considered as the prevailing organism in gas infections. This bacillus is recognized as a strain of Welch's bacillus aerogenes capsulatus showing some technical differences from it. The perfringens is found in the large majority of infected wounds if not in all. West, at the Juilly ambulance found bacilli resembling Welch bacilli morphologically and gram positive in cultures taken from ward blankets dirt of the floors soil of ward flower pots and from the air. The air cultures were made by exposing veal media in Petri dishes in the wards overnight.

The question as to whether the perfringens produces a true septicæmia and circulates in

the blood during life is undecided. It may be found in exceptional cases but is not found as a usual thing. Likewise observations on the toxins vary as to whether the intoxication produces death or whether a fatal issue is due to the absorption of the products of cytotoxicity.

In the vast majority of wounds the perfringens is associated with other organisms anaerobic and aerobic. The Vibron septique of Pasteur an inhabitant of the intestine of man and animals is often met with in the wounds and is capable of giving rise to gas gangrene under favorable conditions. Costa and Troisier have described five groups of bacilli which range between the perfringens and the Vibron septique and which they name the bacilli lyticus. Sacquépée has isolated the bacillus of malignant gaseous oedema and Weinberg and Seguin the bacillus oedematicus which is a different organism. The bacillus putrificus having the same morphological character as the bacillus tetanus is often found. To mention the bacillus A B C of Weinberg bacilli X Y Z of Fleming bacillus ramosus or bacillus diphtheroide of Wright bacillus sporogenes of Metchnikoff the bacillus of Doyen and Yamamouchi bacillus fragilis and different streptococci anaerobes of Distaco is sufficient to close the list of anaerobes with the hope that future investigation may prove the identity of some of these varieties with one another.

Whatever differences of opinion there exists as to the morphology of these bacteria all agree that the vitality virulence, and power of penetration of these anaerobes are remarkable. Fiessinger has found them in an opened gangrenous wound at 4 centimeters depth between apparently healthy muscle fibers. No matter what antiseptic is used the anaerobes may be found as long as there is dead tissue in the wound.

Besides the gas producing bacteria are found to a greater or less extent aerobic organisms. The streptococcus is found in nearly all the infected wounds at some period of their evolution. This organism is generally recognized to be the enterococcus a regular inhabitant of the intestinal tract. The staphylococcus normally present on the skin fre-

quently accompanies the anaerobes. Various varieties of the cocci as the pneumococcus diplococcus, flavus and crassus have been described. The bacillus proteus and bacillus pyocyaneus are frequently met with in the later stages of the wound evolution. Varieties of the colon group and even the bacillus typhosus and paratyphosus have been found in the wounds. Friedlander's bacillus is sometimes found and to complete the list the coccobacillus Verodunensis of Besredka should be mentioned.

#### PHENOMENA OF WAR WOUNDS

The phenomena of war wounds have been ably described by Policard and Philip as a result of their study of the early infection of wounds.

1. Up to the fifth hour after the receipt of the wound no reaction manifests itself. Microscopic examination shows the presence of blood-clots enclosing fibers of cloth, débris of the surrounding tissues, connective-tissue fibers torn nuclei more or less altered muscular fibers traumatized but no infiltration of leucocytes.

2. From the fifth to the ninth hour commences the reaction of the tissues. Migrating leucocytes appear the polymorphous neutrophils, large mononuclear and small lymphocytes. This reaction of healthy tissues is feeble but at the same time the traumatized tissues show signs of degeneration.

3. From the ninth to the eleventh hour approximately the appearance of bacteria is noted large club-shaped organisms, gram positive classified as bacillus perfringens or bacillus aerogenes capsulatus. These bacilli commence to appear in the immediate neighborhood of the cloth fibers and grow in the blood coagula which enclose them.

4. After about the twelfth hour three phenomena dependent one on the other are evolved simultaneously.

a. The bacilli multiply and press out farth from the cloth fibers.

b. There is a production of polynuclear neutrophils of which a small number perform the function of phagocytes. The action of defense of the tissues is clearly insufficient.

c. The leucocytes are altered and are transformed by degeneration into globules of pus but as the production of leucocytes is limited, the pus is not abundant.

5. These phenomena continue slowly at first but are accelerated from the twentieth to the thirty-sixth hour at which time the pus is fetid. Almost always at the forty-eighth hour the anaerobes are associated with aerobic organisms which favor their development by absorbing the oxygen of the media in which they are grown.

*Time of appearance of gas infection.* In general gas infection is an early symptom. It may appear in the first few hours after the receipt of injury and generally is seen in the first few days. Chabier has illustrated by a diagram the date of appearance of gas infection in his cases. The late appearance of gas infection should be noted. This may be produced by the ligation of a vessel for secondary hemorrhage the diminution of the blood supply allowing a flare up of the infection. It may follow a reamputation or show itself in other cases difficult to explain.

*Part of the body affected.* In the great majority of cases it is the legs which are affected. Wounds of the thighs and buttocks are most apt to be soiled by mud and debris and are consequently more apt to become infected. Tuffier has stated that he has not noted a case of gas gangrene of wounds of the scalp skull or brain. He has not met with it in wounds of the face jaws, or neck and exceptionally has he observed it in a wound of the thorax. Brodier however has reported a fatal case of gas gangrene of the scalp.

The following are the notes from a fatal case of infection of the neck.

Patient aged 40 wounded in the neck by a ball from a *Mitrallus* on September 25. First dressing applied one hour after receipt of wound. Incision of wound and drainage tube inserted the following day. Admitted to hospital on September 30 after a railroad journey of several hours. Temperature 100 pulse 40. The right side of the neck showed considerable swelling and induration with a slight amount of repitatio. The point of entrance was situated about mid way along anterior margin of the sternomastoid. Radioscopic examination disclosed the bullet deeply situated in the neck. In spite of two operations for extraction of the bullet and for more extensive drainage symptoms of gas gangrene developed rapidly and death resulted on October 6.

#### PATHOLOGICAL ANATOMY

The changes in the skin correspond to the stage and extent of the infection and vary from slight swelling to more or less extensive color changes. The modifications of color have been noted by many observers. The skin may be of a white porcelain appearance but there is almost always discoloration of

different hues—rose yellow brown violet bronze or copper color black. These changes in color are either to be seen affecting a large area around the wound or they may show themselves in irregular patches following the lymphatic tracts. The color changes are probably dependent on destruction of small blood vessels with resultant hæmorrhage into the skin. Vesicles of various sizes may be seen on the skin. These contain bloody serum which is usually sterile.

The region of the wound or the limb is increased in size and the anatomical outlines changed by the swelling. By incision gas and œdema are disclosed varying in predominance. The wound shows necrosis of the tissues. The surface is covered with a dirty greenish slough. A thin brown or chocolate colored discharge drains from the wound. Gas bubbles are mixed with this discharge or may be squeezed out by pressure on the tissues. Examination of the deeper structures shows that the affected muscle varies in appearance according to the extent of the process. In the earlier stages the affected muscles are pale or copper colored. In the more advanced stage they resemble an atelectatic lung and are black in the final stage. The muscles above and below the wound show œdematous infiltration. Gas bubbles may be observed along the intramuscular spaces. The odor is sharp unpleasant and quite characteristic.

The bacilli are found in great numbers in the tissue fluids. They are also present in the blood. The heart and large vessels show numbers of gas bubbles. They may also be found by microscopic examination of the muscles and liver.

#### SYMPTOMS AND CLINICAL FORMS

Much confusion exists in this subject. Different observers have described symptoms and forms as they have seen them: some near the trenches receiving the freshly wounded others not seeing the wounded until several days have elapsed since the receipt of injury. Others have attempted to distinguish different varieties caused by different specific bacilli.

After a period varying from twelve hours to several days the manifestations of a specific infection show themselves by pain

swelling and tension of the wound changes in the pulse and the mental condition. The subjective symptom of pain is most important and may be considered as a signal symptom. When a wounded man who has had his wound dressed and has been made comfortable complains that the dressing is too tight, it is well to take down the dressing and examine the wound. Palpation of the tissues shows increased tension and sometimes gas crepitation but this is not usually felt at an early stage. The swelling is limited to the region of the wound or to the entire limb and is caused by the œdema and later by gas and manifests itself as an œdematous or gaseous form according to the preponderance of one over the other. Rapidity of the pulse with or without irregularity is apt to be an early symptom. Changes in the mental state show themselves by a dulled resigned somewhat apathetic condition which may be noted in the early stages.

The wound discharges a thin brownish pus and pressure may expel some gas. Discoloration of the skin shows itself in various hues varying from a porcelain appearance to black. These modifications of color show themselves around the wound or in irregular patches along the limb. The vesicles appear suddenly but are often not present.

The presence of gas varies in intensity and is shown by percussion giving a tympanic note and palpation reveals crepitation. A razor moved over the skin gives a special tone called attention to by J. Quénu. The gas spreads rapidly within the first twenty-four hours of its appearance commencing by developing around the wound then spreading up and down, following the vascular tracts to the axilla or groin where it may form air pockets. Later it invades the flanks scrotum chest, or abdominal wall. In some cases it seems to arrest itself at Poupart's ligament. In those cases where the infection continues to spread the limb becomes cold, sensation is lost, the pulse disappears and the local death of tissue progresses rapidly. The extension of the gangrene sometimes is rapid lightning-like, *foudroyante* and in two or three hours signs of putrefaction are seen.

The odor is *sui generis* nauseating and not



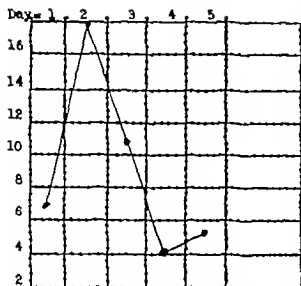


Fig. Chart showing time of appearance of gas infection.

to be forgotten. It is the ammoniacal or fetid odor of decaying flesh. The odor is not present early and must be considered a late symptom. One should not wait for it to make a diagnosis. The odor diffuses itself quickly and permeates the ward. It is very persistent and resistant to disinfection.

Accompanying the local signs are the constitutional symptoms of fever and changes in the pulse. The fever is variable. The temperature is normal at first and ascends abruptly when signs of gas infection manifest themselves. It may descend in a few hours or become subnormal which is a symptom of bad omen. The pulse increases in rapidity and becomes smaller or irregular from the onset. The frequency of the pulse increases to the end even with a falling temperature. The pulse is a symptom of great importance and its character and rapidity is a good indication of the condition and gravity of the case. The appearance of the patient is rather typical in severe cases. The face has a leaden or subicteric hue, sometimes icteric. The mental condition is one of torpor and varies with periods of agitation. The mind may be remarkably clear and tranquil at the end and a soldier has even been known to ask for and smoke a cigarette an hour before death.

In the fatal cases the pulse becomes im-

perceptible the respiration becomes shallow and irregular the body becomes cold and death ensues with the patient in a state of collapse.

In favorable cases where proper treatment has been carried out improvement is shown by the limitation of the infection. The edema and gas become lessened and the skin assumes a more normal color. The discharge lessens in amount and becomes more like a simple suppuration. The sloughs separate from the wound and the margins show signs of granulations. The general condition of the patient improves but apprehension is felt on account of the slowness of the improvement. If the local condition improves, in a few days a change for the better should be noted in the pulse and facial expression of the patient.

#### CLINICAL FORMS

Much difference of opinion exists regarding the different clinical forms and different methods of classification have been attempted. Thus according to whether the edema or gas predominates different forms have been described. Where the clinical picture depends on so many elements as the depth and extent of the lesion, the degree and rapidity of the spread of infection there is opportunity for divergent classifications. Numerous forms have been described but these forms correspond largely to the different stages of invasion.

One of the simplest classifications is that of Willem's of the Belgian army which is as follows:

1. The mild or superficial forms.
2. The severe or deep forms.

1. Under the mild forms are recognized the cutaneous and subcutaneous varieties. The cutaneous form shows itself as an edematous zone around the wound with crepitation present and sometimes bronzing of the skin—*erysipèle bronzé*. The condition is not dangerous but causes apprehension. Improvement is to be expected in a few days. A second superficial form called malignant white erysipelas has been described. This form is characterized by a white porcelain-like appearance of the skin, slight formation

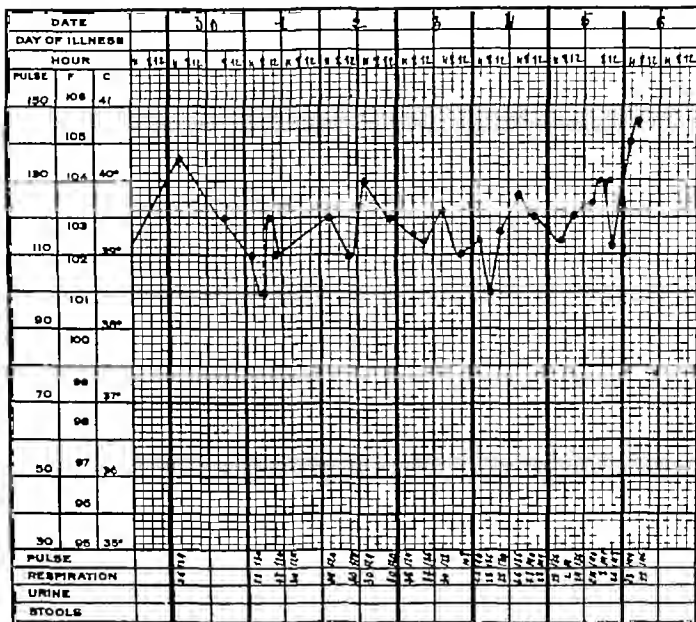


Fig. 2 Chart made in case having deeply situated bullet in neck.

of gas but marked oedema. The subcutaneous form is the gaseous phlegmon or cellulitis. In this variety the infection is limited to the subcutaneous tissue and manifests itself by a zone of crepitation limited to the cellular tissue and shows no tendency to infiltrate the deeper tissues.

The severe or deep cases. These are characterized by oedema and extensive gas formation spreading from a deep origin of muscular infection. The odor and brownish discharge are present. Severe general symptoms develop the limb goes on to gangrene and the patient to death unless intervention is successful.

According to the predominance of symptoms among the severe cases have been distinguished gas septicaemia caused by the *Vibrio septique* of Pasteur and malignant gaseous oedema dependent on a special anaerobe of Sacquépé. The first form is characterized by extensive gas infiltration, diffuse muscle gangrene, moderate and limited oedema. In the later form the oedema predominates, the area of muscular gangrene is circumscribed and the gas is less evident.

#### DIAGNOSIS

As it is well known that almost every wound of modern trench warfare is contaminated

with gas bacilli the mind of the surgeon is constantly alert to recognize gas infection. The eye recognizes the swelling and the skin discolorations, the fingers recognize the tension and crepitation and the nose recognizes the odor. A well-defined case can hardly be mistaken. In early cases before crepitation has developed there may be some difficulty in making a positive diagnosis. The early diagnosis is of the utmost importance as a few hours hesitation is often fatal. The early discharge of thin brownish fluid from the wound should be noted and in case of doubt, an incision should always be made. When crepitation is present the diagnosis is easy and can only be confused with a few conditions.

Wounds of the *thorax* with subcutaneous emphysema. The character of the wound, physical signs of pulmonary involvement and extensiveness of the emphysema would readily lead to differentiation.

2. The entrance of air into the path of a projectile is differentiated by the lack of general symptoms, the limitation of the emphysematous area to the lesion and its rapid absorption.

3. Wounds of the rectum resulting in an emphysematous abscess. Prompt incision would clear up the diagnosis in this case.

4. The crepitation of a comminuted fracture might be mistaken but a careful examination would establish the diagnosis.

5. The crepitation and urticarial plaques of antitetanic serum might cause a momentary confusion.

The bacilli may readily be found microscopically in the wound secretions. The blade of a Paquelin cautery will set fire to the hydrogen sulphide of the gas and will have no effect on the gas of mechanical origin (Guenot).

#### PROGNOSIS

The prognosis depends on whether the patient receives proper treatment early. A superficial infection or a deep infection receiving proper treatment in reasonable time yield good hopes of recovery. The mortality is high in the deep forms and one can more often predict a fatal result in severe forms than a recovery. The cedematous forms have a worse prognosis than the gas forms. The so-called white erysipelas has a bad prognosis almost certain death without amputa-

tion. 25 per cent recovery with amputation. Diffuse forms or cases in which the spots multiply rapidly offer little hope. Dyspnea, icterus and small rapid pulse are bad symptoms. It is difficult to designate the mortality in figures as collected statistics have not been published. There is wide latitude in the statistics of individual surgeons depending on the location of their post, the character of wounds treated and the intervals of time that elapse between the receipt of the wound and the admission to the service. Mortality records would probably vary from 10 to 50 per cent depending on these and other factors.

It is noticeable that many more cases of gas infection are seen after heavy attacks when the wounded are transported in large numbers. This may be explained by the relatively longer period of time spent on the battlefield after being wounded than in times of comparative inactivity. Also the vast numbers of wounded overcrowd the service and individuals do not receive the attention that they do at other times. It has not been infrequent at these times of great activity for masked cases of infection to develop on the trains and for these patients to arrive at their destination in a moribund condition.

#### TREATMENT

1. *Prophylactic measures regarding trench and personal hygiene.* Trench hygiene must be carried out as carefully as possible. To obviate the mud under foot, straw and pieces of wood are laid down in some trenches. Other trenches are built up with cement. The care of the latrines is indispensable. In spite of all precautions the presence of mud and dirt is inevitable in the present method of trench warfare. Fauntleroy has suggested disinfecting the trenches by coatings of whitewash.

Regarding the soldiers' uniforms, a firmer cloth like khaki would be easier to clean and would not be as favorable a habitat for bacteria. Some of the officers wear khaki but it is doubtful if any general change in the soldier's uniform will be made. It has been suggested that the cloth of the uniforms may be impregnated with some antiseptic which

may prevent the cloth fibers when carried into the wound from disseminating infection.

Maintaining individual cleanliness in trench warfare is difficult in times of comparative calm and impossible in times of activity. Bathing facilities are established within safe but accessible distances from the front lines. Some of these are large enough to handle a regiment in a few hours. Every man takes a hot shower bath, receives a close hair cut, and his clothes are sterilized by live steam. Before an attack soldiers are instructed to put on clean underclothes as far as possible.

The duration of time spent by the wounded on the muddy battlefield is undoubtedly a factor in the contamination of wounds, and although this period is abridged as much as possible, yet more or less of this exposure is inevitable. The first aid packet and iodine ampules have proved a failure as far as preventing infections in shell wounds. The dressing is too small for many of the wounds and the amount of iodine entirely inadequate. Also the fragment of shell and piece of cloth are carried into the wound and infect it and remain there beyond the reach of these measures. For rifle wounds the first aid packet is undoubtedly useful.

Preventive vaccinothraphy has been attempted but the results thus far have not been sufficient to establish confidence in this measure. Wright has prepared an anti-gangrenous vaccine to be used in mixed infections. Weinberg and Seguin have prepared an auto-pyo-vaccine. These measures to be at all successful must be practiced as early as possible after receipt of the wound.

2. *Prophylactic measures against gas bacillus infection or abortive treatment.* A certain number of cases of this infection are inevitable, especially when the number of wounded is very large and measures must be taken to reduce this number to a minimum. Early intervention within twelve hours is of utmost importance in preventing the infection. This intervention should consist of a thorough opening up and cleansing of the wound with the removal of dirt, pieces of projectile, clothing and other foreign bodies that may be present. The attempt at removal of the projectile may not be successful without the

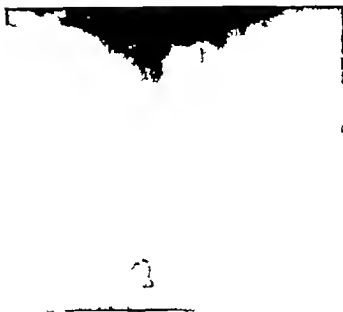


Fig. 3. Roentgenogram showing deeply situated bullet in neck.

aid of an X-ray apparatus and such a procedure is not always possible at such an early time. However, the lack of a roentgenogram should not prevent the above measures being carried out, such as the opening up of the wound and creating a condition unfavorable for anaerobic bacteria is most important. At the same time hemostasis should be attended to and excision of damaged tissue that does not bleed and is doomed to slough should be undertaken. In addition to these measures the wound should be disinfected. Opinions differ as to the best method to pursue in the first few hours—whether physiological or chemical. Those surgeons favoring physiological cleansing of the wound do so with the idea that an antiseptic is not useful on account of the lack of reactionary phenomena of the healthy tissues surrounding the wound up to the twelfth hour. Normal salt solution or sterilized sea water are the solutions used. For early chemical disinfection of the wound probably the best results have been obtained by the use of Dakin's solution according to Carrel's method. The wound is thoroughly washed out with this solution and special rubber tubes are introduced into the wound and so arranged that fluid injected through the tubes will reach all parts of the wound. The skin is protected by pieces of gauze impregnated with vaseline.

which are spread over it. Gauze soaked in the hypochlorite solution is sometimes lightly packed around the tubes and serves to hold the tubes in position. Dependent drainage at the lowest level of the wound is not provided as this would interfere with the fluid diffusing itself and keeping all parts of the wound moist. The fluid is injected every two hours through these tubes, or a continuous drip may be arranged. The treatment has prevented the development of infection in many cases. When it is necessary to transport the wounded at an early stage proper plint should be applied in cases of fracture and careful observation of the wounded should be made en route.

Although the contagiousness of the infection is not claimed yet isolation of gas gangrene cases is desirable as a prophylactic measure. The odor makes it worth while to remove such cases from the neighborhood of other patients. A fly may transmit infection from one wound to another the presence of these pests should be abolished as fast as possible. For hygienic reason rubber gloves should always be employed in dressings and instruments should be thoroughly cleansed and sterilized. Soiled dressings should be placed at once upon removal in paper bags and burned.

3. *Active treatment of gas bacillus infection.* When the condition is definitely established a swift energetic and drastic line of treatment is called for. As fresh air and sunlight are important the patient should be cared for if possible on a porch or veranda. There is no divergence of opinion as to the necessity of deep and thorough incisions which allow the escape of fluid and gas and expose the tissues to the air. As to the local treatment to institute afterward there are many different opinions. The use of ether is much in vogue with French surgeons and is highly considered. Ether is poured into the wounds and the wounds are lightly packed with gauze which is moistened with ether several times a day and covered with some impermeable material. Iodoformed ether 5 per cent is recommended by some surgeons. In addition to packing the wound with gauze wet with this solution a tube is placed in the

depth of the wound and 10 cubic centimeters of the mixture injected every six or eight hours. The subcutaneous injection of ether by many small injections has also been used.

Quenu recommends the use of hot air at 800° f r bad cases and claims good results from it use. Willm favors what he calls the physiological method. After proper incisions have been made the patient is cared for in an open gallery the wound is covered with only one thickness of gauze and receives a continuous irrigation of 5 per cent salt solution. The employment of this solution produces a profuse lymphorrhea. The use of salt solution of different strengths has also been recommended by Sir A. E. Wright and especially in those cases where the abdomen is involved.

On account of its oxidizing power peroxide of hydrogen solution were expected to act especially on the anaerobic bacteria. It has proved to be an excellent solution for cleansing a wound and for loosening up clots but it acts too temporary to be of much value and its use has been largely discarded.

Probably the most consistently good results have been obtained by Carrel's method with the use of Dakin's solution a continuous drip or an injection every two hours. The solution of sodium hypochlorite is antiseptic and at the same time is irritating to the tissues and has the capacity for dissolving necrotic material. The antiseptic power of the solution is due to the chlorine present in an active state. As this method is a most valuable contribution to modern military surgery a description of the method of preparation of the solution is appended.

To prepare 1 litre of the solution weigh 100 grains of calcium chloride or 100 grains of sodium hypochlorite (dry) or 100 grammes of sodium hypochlorite (wet).

1. To make 1 litre of the solution put the 100 grammes of calcium chloride and 5 litres of plaster in a flask and stir for three times and let the contents stand overnight.

2. Dissolve about half the sodium hypochlorite bicarbonate in 4 litres of plaster.

3. Empty the solution of the salt of sodium into one flask and the flask containing the calcium chloride mixture shake briskly for a minute then let it stand to allow the calcium carbonate to form.

4. After half an hour pour off the clear liquid and filter through filter paper. A clear fluid will be obtained which should be kept in the light.

The solution is now ready for use. It contains peroxide

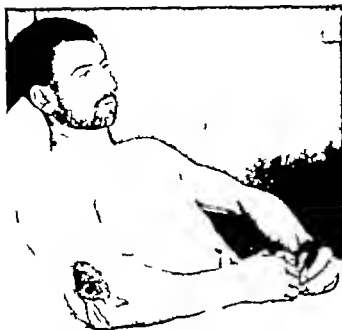


Fig. 4. Case illustrating typical symptoms of gas bacillus infection

imately 0.5 per cent  $\text{NaClO}$  with small amounts of neutral salts of soda. It should be used within a week of the time of its preparation.

As a result of laboratory experimentation Dr. Kenneth Taylor has recommended the use of quinine hydrochloride for gas infection cases either in the form of wet dressings or as a continuous drip. For the former a 1 per cent solution is used and for the continuous irrigation 1/10 of 1 per cent solution made up with saline solution or plain water. The 1 per cent solution has also been used for hypodermatic injection into the gangrenous tissue around the wound. This method has been favorably reported and has been used in a number of hospitals.

Early in the war there were expectations that injections of oxygen or hydrogen dioxide into the tissues would be the measure of specific value in this infection but this method has been entirely disappointing and it has been practically abandoned. The method is harmful as it creates false passages and a dangerous tension of the tissues and at the same time it precludes incision of the tissues which is a *sine qua non*.

To avoid the large incisions some French surgeons follow the advice of Michaux and after having made one or more deep incisions



Fig. 5. Case treated by cautery method.

surround the inflamed area by a series of punctures with the actual cautery extending to the aponeurosis. Several cases treated in this manner have come under observation but ignorance of the original condition precludes the formation as to the value of this proceeding.

Morestin's mixture of equal parts of formal alcohol and glycerine has an embalming action on the tissues and has been used for a temporary expedient.

It will not be necessary to examine into all the antiseptics that have been used and mention will merely be made of those that have shown themselves of some value.

- Permanganate of potassium
- Labarraque's solution
- Javel water
- Chloride of zinc, 10 per cent
- Carbolic acid solution
- Iodine solution
- Arseno-benzol and galyol
- Turpentine 15 grammes of essence to 1000 of artificial serum
- Horse serum.
- Artificial gastric juice
- Lactose
- Hypochlorous acid by intravenous injection
- Sodium benzoate and bicarbonate solution
- Magnesium chloride 25 grammes to 1000
- Magnesium sulphate (saturated solution)
- Chlinsky's solution.
- Mentiere solution containing
  - Acid benzoic, 1 gramme
  - Guaiacol 5 grammes
  - Alcohol 4 grammes
  - Water 1 litre

The grand number of these different agents shows the inefficiency of any one of them. None of them are of value without proper incision and this being provided the benefit of the solution is probably due in a large measure to their mechanical cleansing of the wound.

The use of serum therapy is considered a disappointment. Delbet however has reported favorable result from the use of Weinberg and Sequin serum antipyrfringens. If in spite of the treatment outlined the infection continues it must be followed up by further incision which may be successful. When a wounded man is received with a limb in a condition of frank gangrene or when the above described measures have failed amputation must be resorted to as a last measure. The question of amputation is often a difficult one to decide and requires considerable judgment. One should not wait until the extension of the process has reached such a point and the general condition of the patient is such that intervention becomes a hopeless procedure. At the same time one should not amputate because some gas has been disclosed about the wound. A fixed rule can be laid down as to when to amputate in every case must be judged on its own merit. In general it may be said that a combination of general and local symptoms furnishes a picture that decides the question in the mind of the surgeon. The weakening of the body resistance as shown by the bad color mental condition and increased rapidity of the pulse combined with local symptoms of progressive gangrene as shown by increasing discoloration of the skin edema and gas formation together with coldness of the limb and absence of pulsation of the vessels indicate the gravity of the condition which demand action. To have hope of success amputation must be decided on while there is a chance of securing a good result.

Amputation when decided on should be performed speedily and shock should be combated as much as possible. The circulation may be stimulated by injections of camphorated oil ether adrenalin or strophanthin but the best stimulant is hot saline solution

given by hypodermoclysis. This is best given by two needles placed in the subcutaneous tissue of the pectoral region. This injection to be effective should be begun as soon as the patient is on the operating table and the salt solution should be in process of absorption at the time the operation is commenced. No time should be lost in lengthy measures for sterilizing the skin. The application of tincture of iodine or alcohol is sufficient. (2) an anesthetic; the anesthetic paraffin oil its rapidity of action and lack of after depression rendering its superior use.

It is customary to amputate by the classical method of Celui by which all the tissues are rapidly divided at the same level. The wound is left wide open. Sometimes the incision must be made through diseased tissue and secondary incisions should be made for drainage. The flap method may be used in certain cases in which the situation of the wound permits the saving of some skin and a longer length of limb. In such cases the flaps should be left wide open. In general the Celui method is speedier and safer and is in more general use for desperate cases. A secondary operation may be necessary for improving the stump at a later period but that is a matter of comparatively little importance.

The patient should be well protected from exposure and artificial heat should be applied. The hypodermoclysis should be maintained after the patient is returned to bed or it may be discontinued and saline solution administered by the rectum by Murphy's method. The wound should be dressed openly at the original wound. The edges may develop gangrene with sloughing of the muscles. Sometimes the sacrifice of the limb is not successful in saving life. The gangrenous process continues the edema extends and the patient succumbs in a few hours or days.

In cases that survive when the condition of the stump improves somewhat the retraction of the skin can be prevented to a large extent by the use of skin retraction. This consists in the use of four broad bands of adhesive plaster applied to the stump longitudinally or bands of flannel or some other mate-

nal may be glued to the skin by Huesser's glue. These bands are attached to a piece of wood from the center of which a cord runs over a pully attached at the foot of the bed. A weight of two or three kilos attached to the end of the cord is usually sufficient. In order to dress the stump the bands are detached from the wooden cross-piece and laid back.

#### SUMMARY

1 Modern trench warfare with the accompanying difficulties in providing cleanliness exposes a large proportion of wounded to the dangers of gas-bacillus infection.

2 The majority of cases follow shell wounds when a piece of contaminated clothing is carried into the depths of the wound by the projectile.

3 Among the varieties of micro-organisms present in the wounds the bacilli perfringens are generally accepted as the causative organisms. These bacilli appear in the wound from the ninth to the twelfth hour. The aerobic bacteria appear about the forty eighth hour.

4 The symptoms of the infection appear early usually on the second day.

5 The parts of the body most often

affected are the legs on account of the likelihood of their becoming contaminated by dirt and faecal matter.

6 It is of vital importance that the diagnosis be made early.

7 Pain swelling and tension of the wound with rapidity of the pulse are important early symptoms.

8 Vesicles discoloration of the skin gas formation and odor should be considered later symptoms.

9 The prognosis depends on whether the patient receives proper early treatment.

10 Trench hygiene and personal cleanliness are vital prophylactic measures. Early incision of the wound with removal of the foreign bodies cleansing of the wound and excision of damaged tissue doomed to slough are the correct surgical procedure of prevention.

11 When the infection is once established well placed deep incisions exposing the deeper tissues to the air are indispensable.

12 For the clinical treatment of the wound Dakin's solution has given the best results.

13 Amputation must be resorted to in many cases and should not be delayed beyond the proper period.



## THE OPERATIVE TREATMENT OF INACCESSIBLE VESICOVAGINAL FISTULA

H. GEORGE CRAY WARD, J. M. D., IACSON, N. Y.

SINCE Hippocrates first recorded a case of vesicovaginal fistula, surgeons have striven to conquer this most distressing injury. Simultaneously developing a correct technique placed the problem on a sound basis, so that a large number of these unfortunates could be relieved of their sufferings, while Mackenrodt by his contributions to vaginal surgery secured a distinct advance in enabling the urgent repair the injury with greater certainty and ease.

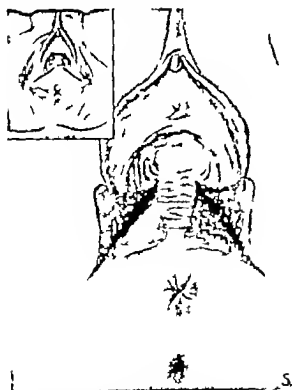
Although the majority of vesicovaginal fistulae can now be cured with comparative facility, still there are cases which tax to the utmost the ingenuity and skill of the cleverest operators, particularly cases where there has been an extensive loss of tissue and those which are difficult to close because of their

inaccessibility. It is the latter type of injury that I wish to bring to your attention.

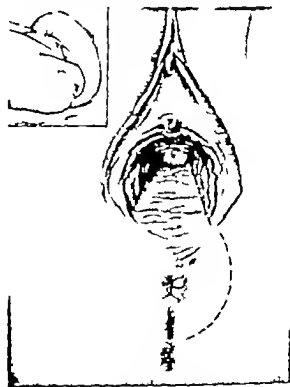
The inaccessible vesicovaginal fistula is not uncommon today, and it is frequently the result of an injury occurring during a hysterectomy.

Sampson in a study of cases at Johns Hopkins found that accidental injury to the bladder during operation for carcinoma uteri occurred in 9 out of 18 hysterectomies, about 52 per cent.

Again the cautery operation for carcinoma of the uterus, recently popularized by Percy, is a common cause of an injury to the bladder wall high up in the region of its attachment to the uterus and the resulting cicatricial tissue at the site of the cautery adds to the difficulty of the repair. The recent de-



Lateral vaginoperineal incisions as made by Dieffenbach and others.



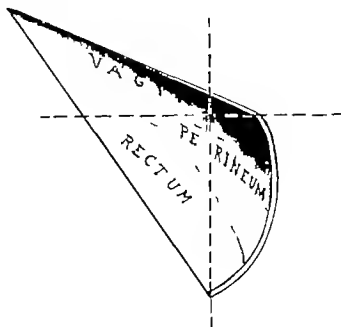
Schuchardt's incision outlined

velopment and extensive employment of the Wertheim operation and the Percy cauterization undoubtedly accounts for the more frequent occurrence of these inaccessible fistula in recent years

This type of fistula is usually not large in size but it is situated in the vault of an atrophied and contracted vagina and is imbedded in the scar tissue which occupies the former site of the cervix.

Inaccessible fistulae have been attacked by many routes with varying degrees of success in the endeavor to avoid that acknowledgment of defeat colpocleisis. These avenues of attack may be grouped into two classes those which are suprapubic and those which approach the fistula from below.

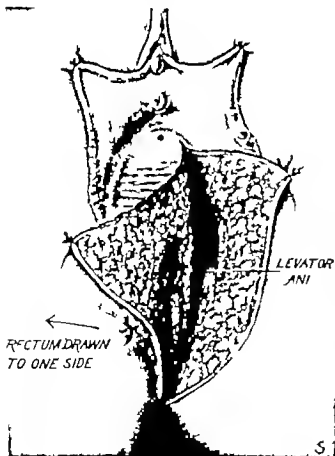
The suprapubic type of operation was first used by Trendelenburg in 1890 and von Dittel Frank Kelly and many others have been advocates of this route. The extent to which Trendelenburg's operation came into



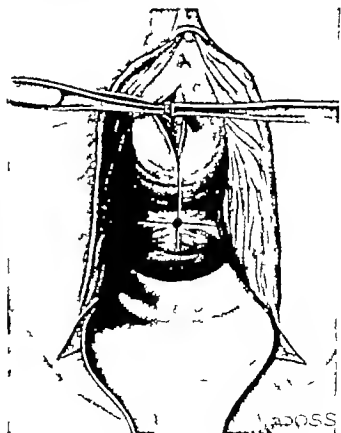
3 Geometric figure of the plane of the incision

use may be gathered from the fact that from 1890 to 1904 some 7 cases are reported in the literature

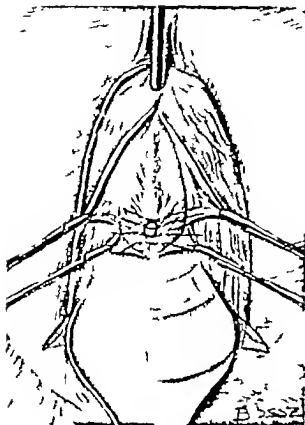
At the best the suprapubic operation



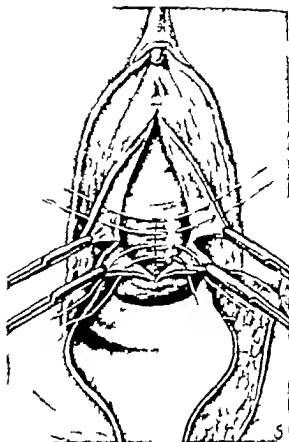
4 Schuchardt's incision completed (drawn from life)



5 Commencement of mobilization of the bladder



(A) Displacement from normal position of bladder means of sound without exploration



Vaginal incision

is more severe and has a greater mortality than the vaginal operation. In many cases it is impracticable owing to fat abdominal wall. Coincident with the development of the suprapubic operation distinct improvement have been made in the method of attack by the vagina so that the necessity for the employment of the larger operation has been greatly reduced. In 1902 Kelly advocated the employment of the knee-chest posture in order to obtain a good exposure of the vaginal vault and the opening of the peritoneal cavity widely from the left side in the line of the transverse scar so as to free the bladder and render it mobile. He then placed a large gauze pad with a tape in the peritoneal cavity and used it as a tractor to bring the bladder within reach.

A decided objection to this method is the danger of infected urine escaping into the peritoneal cavity.

In 1910 I published the method I had successfully employed in two cases, the guiding principles in the technique being the thorough and extensive separation of the bladder base from the anterior vaginal wall and then from the adhesions above the vault and the displacement of the new movable bladder downward through the large vaginal incision, so as to bring the fistulous opening within easy reach.

This was accomplished by

1. The employment of deep paravaginal incision to render the field of operation more accessible.

2. A longitudinal median incision of the anterior vaginal wall extending from the urethra through and beyond the fistula, and a lateral incision across the full width of the vaginal vault. Then the thorough separation of the base of the bladder from the vagina and adhesions, being particular to commence the

dissection in the lower vagina, where there is an absence of scar tissue in order to establish the line of cleavage

3 Displacement of the bladder into the vaginal cavity by means of a sound passed through the urethra

4 Suturing the opening in the bladder with catgut and closing the vaginal incision with silk worm gut, being careful to catch the base of the bladder to one side of the site of the fistula, so as to bring the lines of suturing in different planes

In 1913 Kelly in a further contribution advocates the same procedure as in 1902 but uses the lithotomy position instead of the knee chest, and states that it is not always necessary to open the peritoneal cavity

The method to be employed in each case must of course be determined by a careful study of the conditions present. In some cases the suprapubic method may be the only choice in others a combined operation may be necessary but the vaginal route should be tried first, provided it promises a fair chance of success

I wish to emphasize a few points in the detail of the technique, which my further experience leads me to believe will help to a successful result. The essentials to success are—

- 1 Accessibility
- 2 Free mobilization of the bladder
- 3 Displacement downward of the bladder
- 4 Correct suturing

1 Accessibility. This is best obtained by the free use of the paravaginal incision of Schuchardt

It is rather strange that in America a correct conception of this incision and appreciation of its value is rare. In the minds of many operators confusion exists between Schuchardt's incision and the ordinary lateral vaginoperineal incision, which is similar to a simple episiotomy. The two incisions are totally different and there is no comparison as to their effectiveness in procuring accessibility.

The simple straight vaginoperineal incision is superficial and much less extensive as compared to Schuchardt's. Its length is limited by the pelvic wall and it is usually

necessary to make one on each side of the perineum

It is rarely necessary to make a second incision when Schuchardt's method is employed and if properly made it causes no injury to important vessels or nerves while the simpler incision if extended toward the pubic ramus far enough to give sufficient working room may injure the lower end of the bulb and the internal pubic and inferior hæmorrhoidal vessels and nerves

Schuchardt first described his incision in 1893 for the radical vaginal extirpation of the carcinomatous uterus and Schauta and others have adopted it in their vaginal operations for cancer

In 1896 he advocated its employment for other conditions besides carcinoma of the uterus and reported a case of its successful use in rendering accessible a double vesico-vaginal fistula which was fixed in scar tissue high in the vagina. In 1901 he contributed a further study of his incision with an anatomical report by Waldeyer

Vaginoperineal incisions have been employed by many operators prior to Schuchardt's description of his operation in 1893 notably Duchrssen Leopold Chaput, Picque and others but as Sinclair remarks it is not fair to speak of Schuchardt's method as a mere extension of these incisions it is a distinctly beneficial addition to the resources of operative gynecology. Sinclair made Schuchardt's incision on the cadaver and had the anatomical relations studied by Young

Doederlein and Kroenig state Schuchardt worked out an operation of his own which has proved to possess extraordinary advantages in the extirpation of carcinoma. special attention must be called to the fact that Schuchardt's incision differs essentially from these lateral incisions, and that it increases to quite an unexpected extent the facilities of access to the uterus and its vicinity

Gellhorn says The effect of the paravaginal incision is surprising. In place of a vaginal tube we have before us a shallow excavation not deeper than one inch.

The value of this incision as a means of procuring accessibility to the upper vagina and pelvic cavity is shown by the fact that

being done by the ordinary vaginal technique and the second by the suprapubic transvesical method of Trendelenburg.

Ashton in a personal communication states that he has operated on three cases by this method all with success and he considers it not only good for high fistulae with the surrounding parts fixed by adhesions, but in the light of his experience he believes that it facilitates the ease and certainty of technique, in fistulae low down in the vagina.

Anspach has employed the operation in one case following hysterectomy with a successful outcome.

I have recently had the pleasure of seeing Cullen do the operation on a difficult case in which the uterus had been previously removed for carcinoma with a cure.

My own experience in the repair of the inaccessible type of vesicovaginal fistula consists of five cases all of which were successful. Two of the cases I have reported in my original paper.

**CASE 3.** Mrs. E. K., age 44, had a hysterectomy in August 1913 for an intraligamentous fibroid and during the course of the operation the bladder was evidently injured, as shortly afterward she developed a leak in the vagina. I first saw her in November 1913. Examination revealed a typical inaccessible vesicovaginal fistula. A hole the size of a pea which communicated with the bladder was situated in the vaginal vault; the transverse sac which occupied the former site of the cervix. The gynaecoscope showed the opening in the upper part of the trigone near the left ureter. Although the patient had had two children the pelvic floor was undisturbed. I operated in November 20, 1913, making typical Schuchardt's incision, carrying out the technique as described. The bladder was drained with a self-retaining catheter for six days.

A letter received in August 1916 states that the fistula has remained closed ever since.

**CASE 4.** Mrs. P. D., age 32, an Italian woman, enormously fat, weighing over 300 pounds. She had a very difficult instrumental labor which had resulted in a large vesicovaginal fistula, the size and shape of a five-cent piece, situated high up in the upper margin being in contact with the stump of the cervix which had been torn off. The uterus was firmly fixed in the pelvis and could not be drawn down. Owing to the excessive amount of fat and the contracted vagina the result of cicatricial tissue the case was a most inaccessible one. I operated on November 20, 1915. The Schuchardt incision gave good access to the field of operation, but the size of

the opening, the dense adhesions and a profuse capillary hemorrhage which continued throughout the operation added greatly to the difficulty. It was the most difficult case I have experienced, but the closure was finally satisfactorily accomplished by the technique described. The bladder was drained with a catheter for 7 days. The result was all but perfect—a small hole the size of a pin head persisted in the middle of the vaginal wall in an accessible situation and I closed it with comparative ease at a subsequent operation on February 5, 1916, by a simple dissection and suture.

The result has been a permanent cure.

**CASE 5.** Mrs. C. M., age 53, an Italian woman, 5 feet 10 inches tall, presented herself at my clinic with a well advanced epithelioma of the cervix. The case could have been a suitable for Wertheim operation, as the uterus was not fixed and the broad ligaments did not appear to be infiltrated, but owing to her obesity I employed the Percy and Ry method on April 16, 1916. The tissues were satisfactorily cooked for one hour, the uterus penetrated to the fundus, the abdomen being first opened.

The patient made good recovery but developed multiple original fistulae in the vault of the vagina imbedded in the dense cicatrix. No sign of the cervix remained. On September 8, 1916, one year and five months after the operation examination disclosed no evidence of recurrence. The patient had retained her weight, looked well, felt well, did her own housework and had no symptoms except the leakage.

On September 25, 1916, I operated upon her to close the fistula by the technique I have described. The operation was not especially difficult and the results were successfully closed.

## SUMMARY

The point that I wish to emphasize in the closure of inaccessible vesicovaginal fistulae by the vaginal route may be summarized as follows:

1. Schuchardt's incision is our most effective means of obtaining free access to the vaginal vault for operative procedures in difficult cases.

2. This incision should not be confounded with the ordinary straight lateral celio-peritoneotomy.

3. The incision is a distinct addition to the resources of operative gynecology.

4. Free mobilization of the bladder is an essential requisite to the successful closure of inaccessible vesicovaginal fistulae.

5. Free mobilization of the bladder is most easily obtained by first establishing the

plane of cleavage between the uninjured vesicovaginal tissues

6 Displacement of the bladder injury downward within reach by means of a sound in the bladder used as a lever and counter point, is a decided aid

7 Care should be taken that the sutures are placed in the bladder and vaginal walls in such a manner that the lines of incision are not superimposed

#### CONCLUSIONS

I wish to echo the statement of Jeff Miller that Modern surgery furnishes no more striking illustration of the advances made in plastic technique than is shown in the methods now employed in bladder fistulæ, and I wish to emphasize the truism that the most successful surgeon of the future will be he who with a wide knowledge of all the methods at his command chooses the one which will be the most suited to the individual case

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THE SURGICAL METHODS OF DEALING WITH PELVIC INFECTIONS<sup>1</sup>

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ALTHOUGH pelvic infections form no small a proportion of the cases coming under the care of the abdominal surgeon and often give him much anxiety, their consideration at medical meetings is frequently relegated to the back ground for some newer, more interesting and yet less important topic. This evening I shall not attempt to cover the subject, but in the necessarily limited time at my disposal I wish to outline the methods that I have found most satisfactory in dealing with these infections.

The methods here described have not been developed by any one man, but are due to the gradual crystallization of the knowledge gained from the wide experience of many men and from the greater insight into the pathology of the various lesions that has come to us year by year.

## THE METHOD OF HANDLING AN APPENDICEAL ABSCESS

An appendix abscess may or may not be pelvic. As it is on the border line, however, I shall describe briefly the method of treatment that has given me the greatest satisfaction. In the past considerable controversy has been waged as to whether the abscess should merely be opened and the appendix left behind, or whether the appendix should be removed at the same time. During the past ten years I have always found it possible to remove the appendix at the time the abscess was drained.

What is the usual site of an appendix abscess? It generally lies between the cæcum and the right lateral abdominal wall and, as a rule, is covered over by a corner of the omentum. It has been the retrocæcal position of the appendix that has enabled nature successfully to wall-off the inflamed area. Had the appendix been lying relatively free there would have most probably followed in association with the inflammation and subsequent gangrene a general peritoneal in-

fection instead of a localized abscess, unless the appendix had become rolled up in the omentum.

How can we deal with the appendix abscess without spreading the infection? After making a gridiron or a longitudinal incision, as may be deemed most expedient by the individual surgeon, we at once encounter the adherent omentum. This is plastered over the surface of the cæcum or may be lightly adherent where the cæcum joins the lateral abdominal wall. To attempt to wall-off the abscess area for the time is impossible. If gauze is packed upon the omentum, it will be like packing down upon a spring board and if too much pressure is exercised, the omentum where it is adherent to the abscess may tear away and pus will often trickle out from the abscess, run over the cæcum and escape between intestinal loops. We must, therefore, adopt a method that will enable us to completely wall-off the abscess before it has been disturbed. This is readily accomplished by packing up the omentum just to the inner side of the cæcum, doubly ligating it (Fig. 1) and then cutting between the two rows of ligatures (Fig. 2). The healthy omentum is then pushed back into the abdomen and the abscess to which the distal portion of the omentum is still attached is completely walled-off. Packing is also carried up toward the right renal pocket and down into the pelvis on the right. After the walling-off is complete and the edges of the abdominal incision are properly protected, the distal portion of the omentum which is adherent to the abscess may be gently pulled away. If it is only lightly adherent. This omentum often represents the cork of the abscess sac and pus at once commences to well up (Fig. 3). The pus is wiped out as rapidly as possible and if we now draw the cæcum away from the abdominal wall the appendix, or what remains of it, at once comes into view and can be removed. Sometimes the omentum is densely glued to the cæcum. In such cases

the abscess is reached by bluntly dissecting the cæcum away from the abdominal wall the adherent omentum not being disturbed

One drain is laid to the floor of the abscess one up in the right renal pocket and one down in the right side of the pelvis. Where drainage alone is desired I use a cigarette drain with little or no gauze protruding from the end. But where there is much capillary oozing this is of little value because it is necessary to have the gauze come in direct contact with the bleeding area otherwise bleeding will continue. On at least two occasions I have had to bring the patient back to the operating room remove the completely covered cigarette drain and replace it with one that had an ample supply of exposed gauze at its inner or cæcal end. The direct application of the gauze to the oozing area is absolutely necessary to check the capillary oozing. Where a right rectus incision has been employed, it is usually wise to make a second incision in the right iliac fossa and to bring the drains out through it. The longitudinal incision is then closed.

#### THE METHOD OF DEALING WITH PUS TUBES

The greater number of pus tubes are probably due to gonococci. I say probably because we rarely open an abdomen for an acute gonorrhœal infection but prefer to employ cold or heat to the abdomen and use hot vaginal douches. The majority of the pus tubes we remove are quiescent and have been of long standing and the organism responsible for the infection has long since died. And although a gonorrhœal infection has undoubtedly been the causative factor we are gradually awaking to the fact that in many instances the pelvic trouble has dated back to an acute attack of appendicitis. In such cases the salpingitis may be limited entirely to the right side or if both tubes be involved the right tube shows more involvement than the left. Dr J. E. Moore of Minneapolis and others have dwelt at length on this subject.

You are all so thoroughly familiar with the technique of the supravaginal removal of the uterus together with the tubes and ovaries that I shall omit any consideration of this

part of the subject. In those cases in which the uterus tubes and ovaries form one conglomerate mass and in which a point of cleavage is almost out of the question, bisection of the uterus as described by Howard A. Kelly is of the greatest help. It not only reduces the time of operation by half but enables one to do much cleaner work.

In many instances complete removal of the pelvic structures is absolutely necessary for the relief of the patient and cannot be avoided. Those of you who have spent years in gynecological dispensaries however fully realize the sad mental and physical condition of the many patients that have had their pelvic organs removed in early womanhood. It makes such a profound impression upon the young surgeon that in future he will bend every energy to the saving of the menstrual function of the patient, whenever feasible. It is often possible to save the uterus and one or both ovaries provided they are not too badly diseased and provided that at the time of operation a small drain is placed in the pelvis and brought out through the vagina. I only wish to refer to two surgical points in the handling of pus tubes. In the first place when removing a pus tube it is always well to take away a wedge of the uterine cornu with the tube. Situated in the cornu around the lumen of the tube are frequently found a few small glands. These occasionally become infected with the tube giving rise to cornual abscesses. I have seen these reach 2 or 3 centimeters in diameter and if they are left behind further trouble is liable to occur. In the next place we occasionally find a large pus tube free throughout the greater part of its course but densely adherent to the pelvic floor. It not infrequently happens that the pelvic floor forms the cork as it were, for the open frimbriated end of the tube (Fig. 4) and the minute one attempts to shell out the tube there is an abundant escape of pus. In such a case if one begins by removing a wedge of the uterine cornu with the inner end of the tube and then cuts across the meso-salpinx it is possible to draw the tube up until it is almost perpendicular. It is then possible to surround it almost completely with gauze (Fig. 5). It can then be shelled



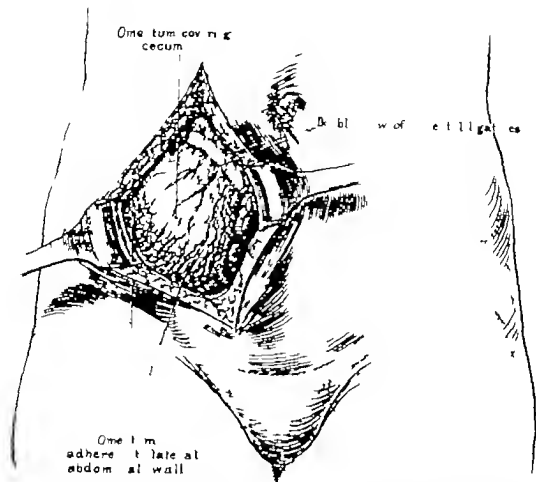


Fig. 5. Step in the treatment of a right iliocecal abscess. In this picture right rectus abdominis has been made and the omentum is found adherent to the cecum and to the right lateral abdominal wall. An attempt has been made to loosen up the omentum. It has been double ligated as indicated by the two rows of sutures. It will now be cut across between the two rows. For the subsequent steps see Figs. 6 and 7.

out with a minimal escape of pus and without soiling the surrounding pelvic structures. Of course the general pelvic cavity must be properly protected before the pelvis is explored. This small point in the technique renders the operation a much simpler and cleaner one.

#### THE PLACING OF A PELVIC DRAIN

This is often a very simple procedure but now and then is somewhat difficult. When the necessary pelvic work has been finished and there is capillary oozing from the pelvic floor or where owing to the nature of the case there is danger of infection a pelvic drain is a great comfort to the surgeon. With the patient in the Trendelenburg position and

with the pelvis carefully walled-off an assistant wipes out the vagina and with a pair of long Kelly forceps presses the posterior vaginal wall up into the pelvis until the elevation on the pelvic floor resembles the peak of a small tent. The operator then cuts down upon the forceps from above. As soon as the tip of the forceps comes through into the pelvis the vaginal opening is made wider either by spreading the forceps from below or by introducing a uterine dilator from above. A large tablespoon (Fig. 6) held against the posterior surface of the pelvic wall acts as an excellent shield or protector for the rectum while the vaginal forceps grasp the cigarette drain and draw it as far into the vagina as the

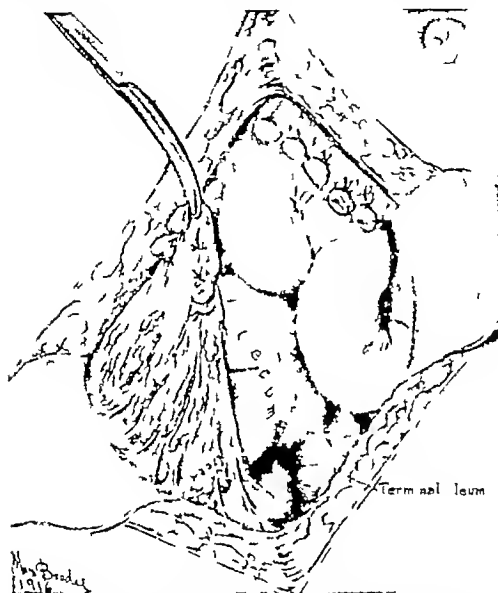


Fig. 2. Step 2 in the treatment of an appendix abscess. The greater portion of the omentum after ligation has been pushed back into the abdomen. The operator can now readily place a cofferdam of gauze above, on the inner side of and below the caecum, thus effectually preventing the escape of pus into the surrounding general peritoneal cavity.

operator deems wise. The surgeon now fits the free gauze ends into the pelvis cutting off any excess that may be necessary and so places the drain that, if possible the gauze does not come in contact with any small bowel.

While this method of placing a pelvic drain seems to be almost ideal a good deal of care must be exercised. On one occasion an assistant had considerable difficulty in bringing the ends of the forceps up in the vaginal vault behind the cervix. Finally he was successful, but when the cut was made a little water escaped. He had carried the forceps in

through the urethra and by his pressure had carried the bladder through the broad ligament and up behind the cervix. In another case an assistant was asked if his forceps were in the vagina and answered in the affirmative. They appeared in the usual place and were cut down upon. Subsequent examination showed that he had introduced his forceps into the rectum instead of into the vagina. I happened to be the operator in each instance. Fortunately in both of these patients the accidental openings were promptly closed and both made excellent recoveries.

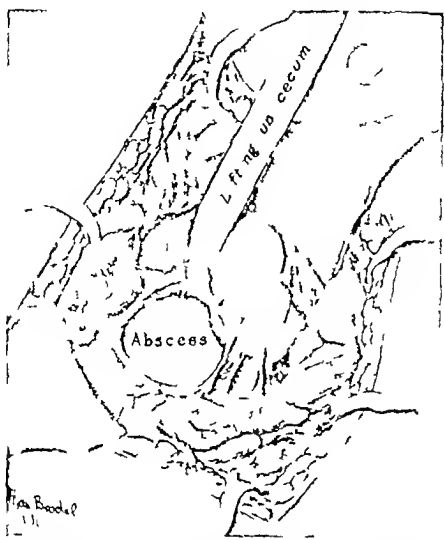


Fig. 3. Step 1 in the treatment of an appendicitis. The portion of the omentum adherent to the cecum and showing the appendix has been removed and the cecum is now gradually separated from its attachment to the anterior abdominal wall. The appendix is then pulled out through the right inguinal region and removed. When the abscess has been emptied the appendix or that remains of it is removed. Drains are now laid inward to the right of the right inguinal pocket down to the bottom of the abscess sac and into the right side of the pelvis next to the pelvic wall. The end of all of these drains is pulled out through an oblique incision in the right iliac fossa.

I have recorded these cases in detail elsewhere.<sup>1</sup> In all cases the forceps should be introduced into the vagina under sight and not by sense of touch.

THE REMOVAL OF VAGINAL DRAINS AFTER ABDOMINAL OPERATIONS

A vaginal drain is usually not disturbed for at least four or five days unless there are

symptoms suggesting that it has become clogged or that it is too tightly grasped by the vaginal opening. If this is suspected the drain is merely drawn down for about half an inch. At the end of the fourth or fifth day half of it is usually removed and on the following day the remainder is taken out.

As was said before when the drain is being laid in the pelvis at the time of operation care is taken to so protect it that loops of small

Kelly and Cohen. Myomata of the Uterus, p. 6



Fig 4. The removal of a large pus tube which is firmly glued to the pelvic floor. Such a tube frequently has an open fimbriated extremity and the peritoneum of the pelvic floor with which it is intimately blended prevents the escape of the pus. Just as soon, however, as any attempt is made to loosen up the outer end of the tube, the pus escapes. In such a case if the tube is loosened up from within outward in other words if the inner end of the tube and at the same time a wedge of the uterine cornu are cut free and the mesosalpinx then divided, the tube can be loosened up as far as its outer ends without any escape of pus. The next step is shown in Fig 5

bowel will not come in contact with it. Now and then, however a loop of bowel does come in contact with the gauze and if the operator attempts to remove the drain on the second or third day he may be chagrined to find that he has drawn a loop of bowel down into the vagina with the gauze. Several years ago I saw such an accident occur. The surgeon at once pushed the loop back into the pelvis but the patient immediately showed signs of collapse and died in a few hours. By the fourth or fifth day the gauze even if it has been in contact with the bowel will have be-

come loosened so that there is little danger that the bowel will come down with the drain. This complication must however always be borne in mind.

#### THE METHOD OF DEALING WITH EXTENSIVE PELVIC INFECTIONS

In order that we may satisfactorily treat cases of extensive pelvic infections it is absolutely necessary that we have a composite view as it were of how the pelvic infection has developed. The inflammation invades the mucosa of the cervix, rapidly extends to

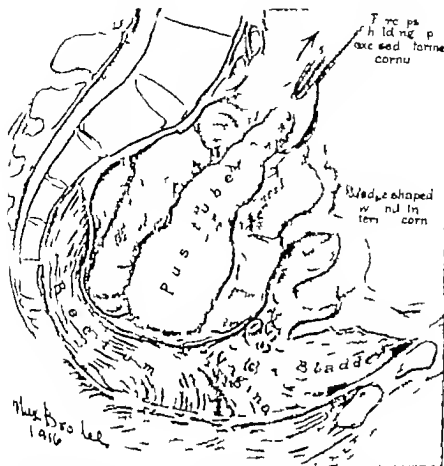


Fig 5 The removal of pus tube. After the tube has been freed from the teres and mesosalpinx, it can be lifted up. It is now surrounded on all sides with gauze and then shelled out from the pelvic floor. Pus will escape but only for moment, and the abscess is effectually lifted off from the surrounding pelvic structures.

that lining the cavity of the uterus and by continuity involves both fallopian tubes. The tubes may become sealed and the inflammation end there. If one or both tubes are open however pus trickles into the cavity of the pelvis and an abscess develops there.

The ovaries with the development of the corpora lutea are subject to considerable variation in size and here and there may show breaks due to the rupture of granular follicles. At such points the ovaries may become infected from the widespread pelvic infection unilateral or bilateral ovarian abscesses resulting. Naturally everything that comes in contact with the inflamed pelvic structures becomes adherent, and consequently the omentum loops of small bowel

the caecum and rectum are often more or less firmly glued to the pelvic contents.

In cases in which on vaginal examination the vaginal vault is board like or where there is marked bulging into the vagina, the proper treatment namely vaginal drainage is perfectly evident (Fig 7). The cervix is drawn forward the vaginal mucosa directly behind the cervix is grasped with a pair of dissecting forceps and the vaginal mucosa cut with scissors. A blunt pair of long Kelly forceps or a uterine dilator can be then readily pushed through the intervening tissue and into the abscess. I feel that it is a mistake to push a sharp instrument into the abscess, as there is always a danger of injuring some structure that has become adherent in the pelvis.

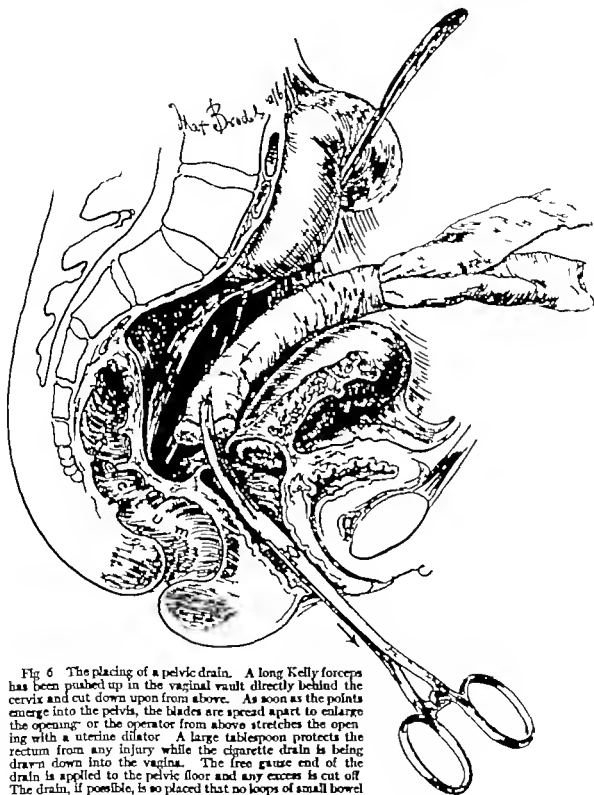


Fig. 6 The placing of a pelvic drain. A long Kelly forceps has been pushed up in the vaginal vault directly behind the cervix and cut down upon from above. As soon as the points emerge into the pelvis, the blades are spread apart to enlarge the opening; or the operator from above stretches the opening with a uterine dilator. A large table spoon protects the rectum from any injury while the cigarette drain is being drawn down into the vagina. The free gauze end of the drain is applied to the pelvic floor and any excess is cut off. The drain, if possible, is so placed that no loops of small bowel can come in contact with it.

vis. A blunt instrument, on the other hand will usually push well organized structures in front of it or to the side and out of harm's way. After the abscess has been reached the vaginal opening is well stretched with a uterine dilator.

When the abscess has been well evacuated a finger introduced into the pelvis will enable the operator to determine with some degree of accuracy whether other abscess pockets exist. Sometimes if a large pus tube is found he either loosens it up with his finger

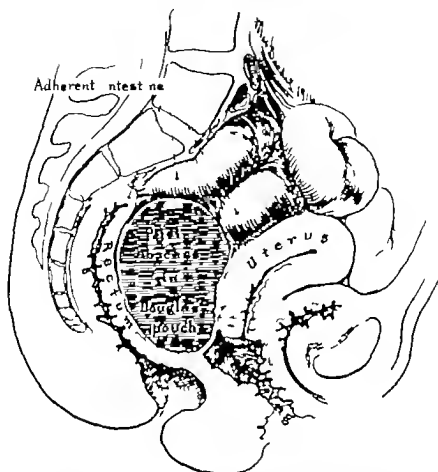


Fig. A pelvic abscess. The abscess filled the pelvis and bulged slightly at the vagina. Frequently the abscess can be marked off on the rectum. The distance between the abscess and the vagina is not over 4 millimeters.

or gently open it with the end of the uterine dilator. With the escape of a large quantity of purulent material when the pelvic abscess is opened the surgeon naturally has an inclination to irrigate the pelvic cavity and wash away the fetid discharge. This should never be done. The greater part of the pus can be removed with gauze sponges. In 1896 I had a patient with a large pelvic abscess. Irrigation seemed to me to be imperative and I irrigated with a boric acid solution. She promptly developed a general peritonitis and died. When we come back again to our composite picture of the pelvic condition present in such a case we find that the roof of our abscesses is made up of omentum and intestinal loops more or less adherent to one another (Fig 8). Any undue pressure from

below such a would be caused by the pelvic irrigation may readily cause the roof to give way. The irrigating fluid mixed with the pus from the pelvic abscess will then be forced up into the general peritoneal cavity and a general peritonitis will almost surely follow. Within the last month I have seen a case in consultation in which a few days after vaginal drainage of a pelvic abscess the cavity had been irrigated. The patient promptly developed a peritonitis which extended above the umbilicus. Fortunately she is recovering.

After as many pockets as can be found have been drained iodoform drains are introduced. In removing the drains the operator must naturally be guided by circumstances. If there be signs of any damming back of the discharge one drain may be removed at

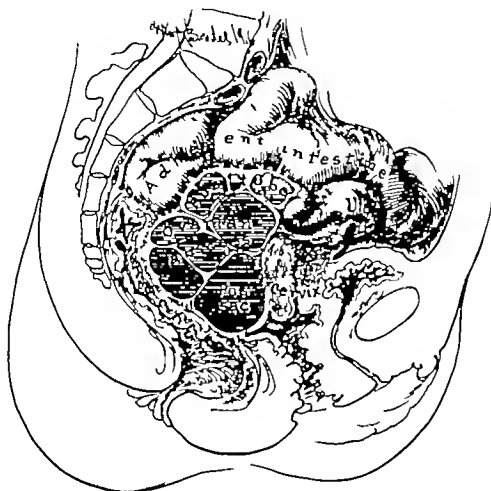


Fig. 8. A composite picture showing a general purulent pelvic condition. The tube on the right is filled with pus. The ovary contains several abscesses, and between the enlarged ovary and the pelvic floor is a purulent accumulation. A similar infection would probably be noted in the left tube and ovary.

Anteriorly the purulent mass is adherent to the uterus posteriorly to the rectum, and partly forming the roof are adherent loops of bowel. The omentum is also often glued to the pelvic mass.

the end of twenty four hours. The drains are usually started at the end of the second or third day about two inches of each being removed at a time our object being to have the abscess sac not only drain but gradually contract down on the gauze. After all the drains have been removed it may still be necessary to stretch the vaginal opening a little and to introduce another small drain.

In all such cases as these the relatives of the patient should at the outset be given to understand very clearly that a subsequent pelvic or abdominal operation or both may be necessary. When draining the pelvis you may have opened every abscess that could be felt and have done your work most thorough

ly. In the following days however other small foci which at the time of the original operation were not over 2 or 3 millimeters in diameter have gone on developing until they now form a well-defined tumor mass. These may spontaneously rupture but frequently they require to be opened.

In cases of pelvic abscess in which the patient is in a good physical condition and no complications exist I usually use the Fowler position at once and often allow the woman to sit in a chair on the following day. These patients improve much more rapidly and the upright position gives ideal drainage.

Where the pelvic infection is high up and when it cannot be well reached from below the abdominal route seems preferable.



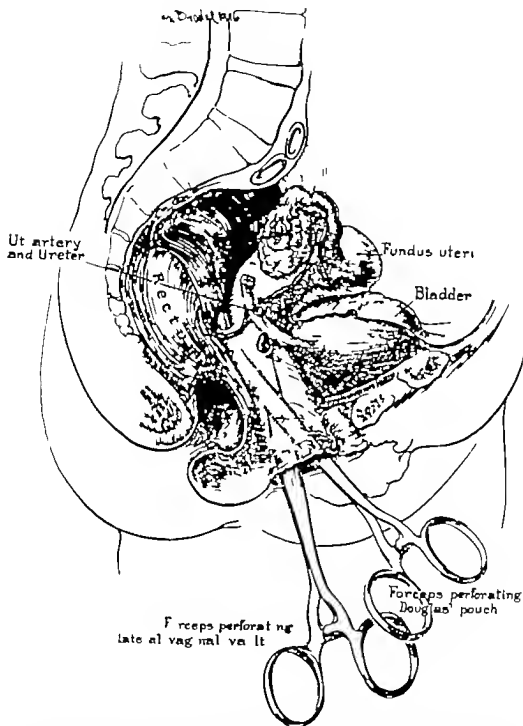


Fig. 9. The method of opening the broad ligament from the vagina. The forceps have been introduced into the vagina and carried to the posterior vaginal vault. In attempting to enter the broad ligament the septum between the vagina and Douglas' pouch is so thin that the forceps will frequently pierce the peritoneum and enter the pelvic cavity. If the operator is successful in entering the broad ligament without injuring the peritoneum his forceps come in intimate contact with the uterine artery and ureter. The best way of reaching the broad ligament is from above as indicated in Fig.

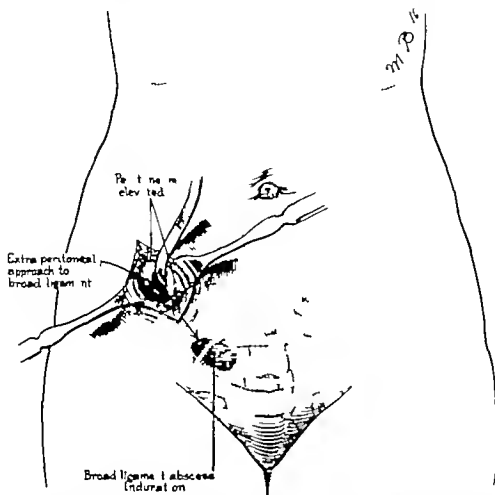


Fig. 10 The easiest and most satisfactory avenue of approaching a postpuerperal broad ligament abscess. A gridiron incision is made above and parallel with Poupart's ligament, and the fascia and muscles are split as in an appendix operation. As soon as the peritoneum is reached it is pushed toward the median line but without being opened. The two index fingers then gradually spread the broad ligament until the area of induration is reached. A little pus or watery fluid will then usually escape. A drain is carried down to the indurated area and the abdominal incision is partially closed. If both broad ligaments are thickened an incision is made on each side. Postpuerperal broad ligament indurations that have persisted for weeks will usually rapidly disappear after being drained in this manner.

#### THE TREATMENT OF POSTPUERPERAL PELVIC INFECTIONS

Many surgeons treat with trepidation the pelvic infections following puerperal sepsis. Let us for a moment compare the clinical histories of those who have had gonorrhoeal infection with those who have had puerperal sepsis. The gonorrhoeal patient if married may have become pregnant before the infection occurred. She has her one child and then as a rule no further conceptions. The woman who has had puerperal sepsis on the other hand frequently gives a history of a very serious illness of long duration following childbirth and then has several children

in succession. What are we to infer from this? In the first place, the woman with the gonorrhoeal infection has usually lost the use of her fallopian tubes and in the second place the woman with the puerperal infection has still left fallopian tubes that are normal or so nearly normal that pregnancy can readily occur.

In most of the puerperal infections that come to the surgeon the focus seems to be in one or both broad ligaments. There is a small hard area of induration or œdema, but little or none of the induration or bulging in the pelvic floor so frequently noted in the non-pregnant pelvic infection. The organism

most frequently found in puerperal sepsis is the streptococcus

Drainage is of course the wise procedure. How can this be best obtained? Where a general pelvic abscess exists one naturally wishes to drain the pelvis. Where the broad ligament is involved pelvic drainage is not only contra-indicated but may be fraught with dire result. In many of the puerperal cases the vaginal vault is little if at all thickened and if an incision is made behind the cervix and Douglas pouch is opened up it may be found to be perfectly moist. During the opening of the vaginal vault one naturally pierces the thinnest area of the broad ligament, and if the broad ligament is infected with streptococci these germs will be carried into the general peritoneal cavity thus adding greatly to the risk. An unusually dexterous operator after going through the vaginal mucosa just behind the cervix may gradually worm his way with the blunt artery forceps up into the right or left broad ligament but his instrument will naturally come into intimate contact with the ureter or uterine artery (Fig 9) and if he happens to pierce the some what brittle peritoneum covering the indurated area his forceps will emerge into the pelvis. Postpuerperal broad ligament infections can be handled from above with the utmost ease and with the minimum risk of entering the abdominal cavity.

A gridiron incision is made above and parallel to Poupart ligament similar to that employed for a simple appendix operation (Fig 10). As soon as the peritoneum is reached it is gently pushed toward the median line. The two index fingers then gradually spread the fold of the broad ligament just as in hunting for the vesical end of the ureter. As soon as the area of induration is reached the operator stops. It is usually hard and edematous. A little watery fluid or pus escapes. A drain is introduced and the operation is completed. If both broad ligaments are thickened a similar procedure is employed on both sides. Indurated areas which have persisted for weeks and months will rapidly clear up. The operation takes only a few minutes and is entirely extraperitoneal.

#### SUMMARY

In the allotted time I have attempted to sketch briefly the salient points in the surgical treatment of pelvic infections. To some of you the entire subject is an old old story to others a few facts may have been new. The point that I particularly wish to leave with you are

1. When an appendix abscess is opened the appendix can practically always be removed at the same time provided the abscess is well walled off with gauze before an attempt is made to open it.

2. In removing a large pus tube that is firmly adherent to the pelvic floor it is better to begin by excising a wedge of the uterine cornu and gradually freeing the mesosalpinx. The tube can then be lifted up as a straight rod and carefully walled-off on all sides before it is hulled off from the pelvic floor. Soiling is reduced to a minimum.

3. Pelvic drains that emerge from the vagina should if possible be so placed that they do not come in contact with the small bowel.

4. Vaginal drains laid in the pelvis during an abdominal operation should not be removed as a rule before the fourth or fifth day on account of the danger of pulling down an adherent loop of small bowel.

5. The vaginal drainage of a pelvic abscess may relieve the patient only temporarily. The development of other incipient abscesses may require several more vaginal operations before the inflammation subsides and even then a subsequent abdominal operation may be necessary.

6. No case of pelvic abscess should be irrigated. There is danger of rupture of the abscess wall and of the escape of infectious fluid into the abdomen which will set up a general peritonitis.

7. Postpuerperal pelvic infections are found as a rule in one or both broad ligaments. Those in the broad ligament can be most satisfactorily opened extraperitoneally through a gridiron incision just above Poupart's ligament. Such accumulations should rarely if ever be opened through the vaginal vault.

THE TREATMENT OF CYSTOCELE AND UTERINE PROLAPSE<sup>1</sup>

By THOMAS J. WATKINS, M.D., F.A.C.S., CHICAGO

**T**HE few minutes I am privileged to use will be devoted to discussion of some of the more important features of the treatment of cystocele and uterine prolapse.

If we recognize and keep foremost in our thoughts the fact that prolapse of the uterus and cystocele of the urinary bladder are essentially hernias the operative treatment becomes immensely simplified. Attention will be centered chiefly in a consideration of the cure of these hernias by operations which change the relative positions of the bladder and uterus — the so-called transposition or interposition operations. The details of this technique will be demonstrated by drawings.

The transposition operation is usually limited to the treatment of patients near or subsequent to the menopause. It is useful in exceptional cases during the reproductive period when the prolapse is extensive and when pregnancy is impossible or inadvisable. This will usually necessitate excision of a portion of each fallopian tube to render the patient sterile.

During the reproductive period satisfactory results can usually be obtained as the hernias then are not generally extensive by the advancement operation of Goffe or by vaginal fixation of the round ligaments.

The transposition operation is the ideal procedure for the cure of cystocele after the menopause. The hernial opening through which the bladder prolapses is thus entirely closed by interposition of the body of the uterus. It makes when properly performed recurrence of the cystocele impossible. Absolute cure of uterine prolapse however is less certain as it is usually impracticable to close entirely the hernial opening through which the uterus prolapses.

*The modified transposition operation.* The transposition operation should be modified in cases with a very large uterus or greatly elongated broad ligaments. In these cases

part of the uterus is excised in some instances only enough of the posterior wall of the uterus is left to give a firm support to the bladder. In case of suppuration this remains intact and insures a satisfactory final result. Excessively elongated broad ligaments can be repaired by detaching portions of them from the cervix and by suture of the cut ends together in front of the cervix.

## RESULTS

Extensive reports of results of the interposition operation in this country and abroad have been very favorable. There has been a small percentage of slight recurrence of prolapse of the cervix or of the fundus of the uterus. With increased experience in selection of cases and modification of technique this should seldom occur. A secondary operation when necessary is usually simple and effective.

*The bladder.* Vesical symptoms frequently exist before and often continue for a time after these operations. Temporary bladder disturbances result from the recumbent position of the patient during convalescence, also from traumatism of the overstretched bladder wall.

My associate, Dr. Curtis is studying the postoperative condition of the bladder both bacteriologically and otherwise and has found that incomplete emptying of the bladder is a common cause of so-called postoperative cystitis.

Considerable distention of the bladder can occur without flatness or other suprapubic evidence of distention. In a recent case thirty ounces were drawn by catheter immediately after urination in the absence of any physical evidence of distention.

We believe that retention of urine is more harmful than catheter contamination.

## DESCRIPTION OF ILLUSTRATIONS

In Figure 1 the cervix is shown pulled downward and held by a volsellum forceps. A free transverse

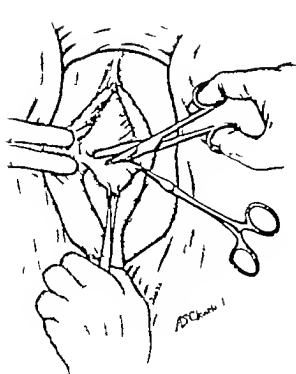


Fig. 1

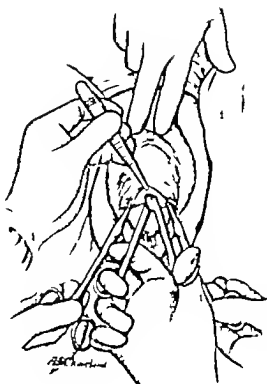


Fig. 2

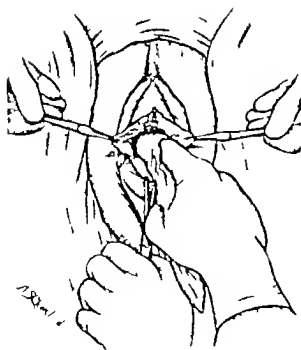


Fig. 3

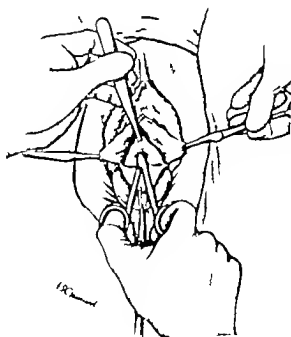


Fig. 4

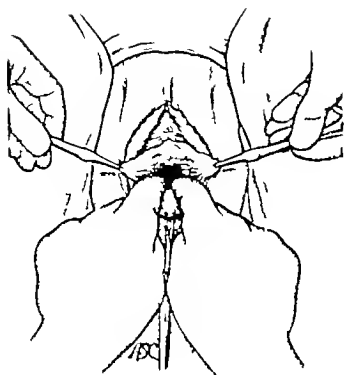


Fig. 5

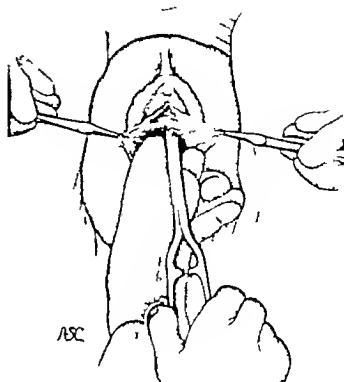


Fig. 6

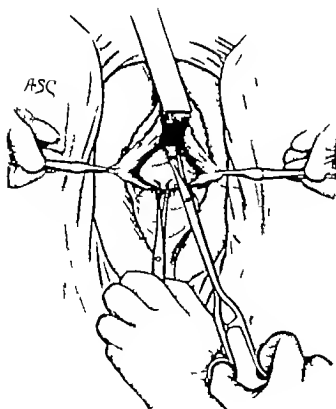


Fig. 7

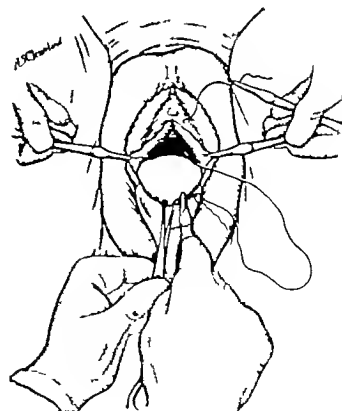
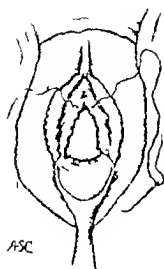


Fig. 8.

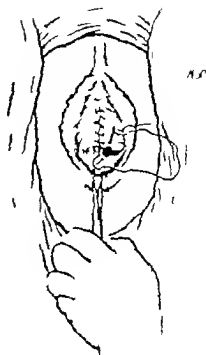


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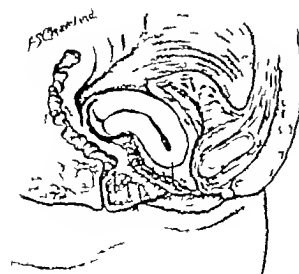
aginal neck is made raw the agina in front of the r.

The agina is separated from the bladder by blunt dissection (the Mayo scissors) as shown in Fig. 3. The incision is made in the plane of fascia between the agina and bladder. A horizontal longitudinal incision is made in this fascia. The point of the scissors is kept close to the aginal neck (1 in) in front of the bladder.

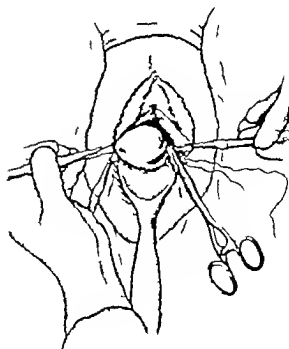
The aginal muscle is used along the median line the whole length of the prolapsed wall (Fig. 3). The plane of dissection between the bladder and rectum



Fig



Fig



Fig

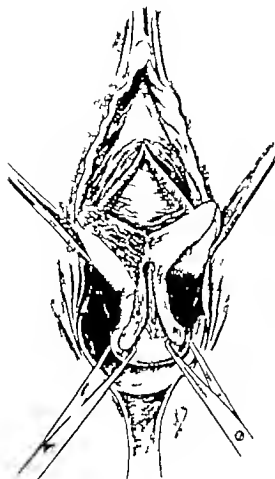


Fig. 3.

is exposed and blunt dissection between the bladder and cervix is here illustrated.

The bladder is further dissected as freely as necessary from the vagina and cervix by the aid of gauze (Fig. 4). It is now advisable to ligate all bleeding points as they are not easily exposed after the body of the uterus is delivered. The control of all bleeding lessens very much the danger of febrile disturbance after the operation.

It is often advisable to excise the anterior lip of the cervix in order to lengthen the anterior vaginal wall and force the cervix upward and backward. The cervix should be amputated when much hypertrophied and elongated.

In Figure 5 the bladder wall has been elevated by a ribbon retractor the peritoneum between the bladder and uterus exposed and incised. The opening is stretched sufficiently to permit easy delivery of the body of the uterus.

Figure 6 shows a bullet forceps under the guidance of the finger or by exposure with a retractor grasping the anterior wall of the uterus.

The anterior wall of the uterus is successively grasped higher and higher (Fig. 7) until the fundus is reached when the uterus is readily delivered into the vaginal canal.

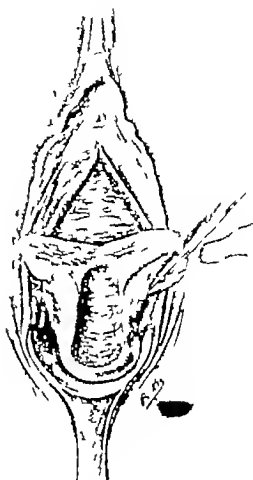


Fig. 14

Figure 8 shows the transposition of the bladder and uterus. The uterus is sutured to the vaginal mucosa and fascia underneath the bladder. The peritoneum is not sutured, as the peritoneal surfaces approximate without suture. In some cases it is advisable to suture part of the wound over the urethra before the suture is carried through the uterine wall. After the first uterine suture is placed and before it is tied the body of the uterus is pushed into the abdominal cavity to guard against strangulation of the uterus.

In Figure 9 the redundant vaginal tissue has been excised. Each suture should include the fascia under the mucosa and pass through the uterus or cervix, and should be so placed when tied that the body of the urethra will be drawn upward in the line of the cervix to its normal location and fixed, and thus restore urinary control.

In Figure 10 the suture of the anterior vaginal wall is nearly completed. A deep suture to either side of the cervix will include the vaginal branches of the uterine vessels and control any bleeding that may be present. Most of the wound is closed with a longitudinal suture so as to lengthen the anterior vaginal wall.

Figure 11 The illustration shows the relative



position of the organ with the completed vesicouterine anastomosis.

Figure 2 shows a portion of the fallopian tube.

Figure 13 illustrates the excision of a portion of the body of the uterus. This is feasible when the uterus is very large and especially with a large uterus completely prolapsed. This is done by running the anterior wall of the uterus in the median line through its entire length as it is delivered to the vaginal canal. A much of the uterine wall is then excised as seems desirable.

All of the mucosa of the uterus may be excised as shown in Fig. 14. In very extreme cases especially if the cervix is amputated all of the mucosa is excised so that tissue of the cervix need not be retained. This is entirely enough of the posterior half of the cervix and uterine body to allow the health of

When this is done the round ligament and the bases of the broad ligament can be included in the uterus so as materially to shorten them.

With this operation the wounded surfaces of the uterus should be thoroughly saturated with half strength tincture of iodine as the omentum in the uterine fundus is contaminated with the vaginal bacteria is very difficult to result. It is also advisable to use some interrupted sutures in front of the cervix.

In the very extreme cases of complete prolapse in old women where there is no objection to obliterating the vaginal canal the entire mucosa of the uterus and vagina may be excised and the hernial opening through which the uterus protruded completely closed.

The operation is complicated by thorough repair of the posterior vaginal wall.

## HÆMOLYTIC JAUNDICE—A REVIEW OF SEVENTEEN CASES

B. H. Z. CHEN, M.D., R. H. M. S. C.

From the M. I. I.

FROM June 30, 1911, to September 13, 1916, seventeen patients with hæmolytic jaundice were under observation.

The disease is of comparatively rare occurrence and may be easily mistaken for other conditions. Twelve of the patients were splenectomized, five were medical. Ten were men and seven were women and their occupations were exceedingly varied. The youngest patients were 9, 13, and 19 years of age respectively and the oldest 49 years. Between the ages of 20 and 30 there were eight patients and between 30 and 40 there were five; the largest number presenting themselves between the ages of 20 and 30 years. Leukæmia, pernicious anaemia and hæmophilia were noticeably absent in the family histories and the patients had no knowledge of relatives with splenomegaly.

**Jaundice.** Seven of the seventeen patients had been jaundiced from infancy. Four others had been jaundiced since childhood and four had an onset between the ages of 18 and 22 years. It is quite probable that in at least ten of the entire series the disease should be classified as congenital in type. There is also evidence that in some of the

patients who had had an onset between the ages of 18 and 22 years the condition should be regarded as congenital. In clinical character, type and severity the symptoms corresponded to the congenital type. Moreover an increased fragility of the erythrocytes in close relatives of patients of this age was demonstrated in two instances. Three cases were definitely familial, six others gave very suggestive histories of familial jaundice. One patient had a history of the onset of jaundice at the age of 32 and another as late as 46 years of age. These were severe cases of the acquired type. The jaundice in all the cases of this series was acholuric and seems never to have completely disappeared. It was remittent rather than intermittent. A tinge of yellow was said to remain after crises and to be present at all times. Several of our patients have stated that their jaundice was increased by excitement and nervousness. In all the twelve operative cases the jaundice was marked. In one patient with complications a trace of bile was at times present in the urine. Undoubtedly very mild cases occur in which the jaundice may be easily overlooked. The jaundice may also

be of very mild grade early in the history of a given case. Pruritus was noted in only one patient in spite of the frequent complication of cholelithiasis.

*Splenomegaly.* In twelve of the seventeen patients the spleen had been palpated previous to our examination. In one patient it had been easily palpable since infancy and in another since the age of 7 years. Others had been recognized as long as ten and fifteen years previous to the examination. All were easily palpable at the time of examination. Mild cases of hæmolytic jaundice occur without an appreciable enlargement of the spleen. I have observed two patients with histories very suggestive of a mild grade of the disease and spleens merely palpable in whom there was an increased fragility of the erythrocytes in the peripheral circulation. On the other hand the spleen in definite cases may be very large though it is never enormous as the spleen of leucæmia or splenic anæmia. In our twelve operative cases it varied from 300 grams to 1780 grams giving an average of 1070 grams, five or six times the normal size. In all of the non-operative cases the spleen was appreciably enlarged.

*Enlargement of the liver.* Two of the five non-operative cases presented evidence of enlargement of the liver. In one of these it was marked. Eight of the twelve operative cases showed enlargement of the liver at operation and in two of these a surgical diagnosis of cirrhosis of the liver was made. The cirrhoses were of the granular rather than the lobulated type and of slight degree. The livers were not contracted. One patient only—an operative case—showed evidence of abdominal fluid; the amount of fluid was small. The liver was much congested but a positive diagnosis of cirrhosis could not be made. Two patients with a severe acquired type of the disease presented upon exploration very large livers. Two patients with a congenital type of the disease and very large spleens, 1250 grams and 1780 grams respectively, had livers which were apparently normal.

*Crises.* Sixteen of the seventeen patients gave a history of attacks, some very mild in character of abdominal distress, nausea, fever, vomiting and headache and when

gall stones were present of seizures of severe pain. Usually these crises were mild during childhood and more severe in later life. In cases of short duration they were milder than in cases of long duration. The patient who gave a history of no crises did however complain of attacks of extreme weakness. The most important evidence that can be obtained from the history in arriving at a differential diagnosis of hæmolytic jaundice is recurrences of deepening jaundice with crises.

*The blood picture.* In these patients a history of severe recurrent anæmia was not obtained. In two instances only was the anæmia severe. In a majority of the cases it was of moderate degree and chronic type. The hæmoglobin in the twelve cases varied from 24 per cent to 86 per cent and averaged 59 per cent. In the entire group of seventeen cases the lowest erythrocyte count was 1,340,000. In two patients the counts were between one and two millions, in one between two and three millions and in seven between three and four millions. The color index was as a rule high. In two instances it was more than 1.0; in five it was 0.9+ and in nine it was 0.8+. The uniformly high color index is quite definitely indicative of the myelotoxic factor in the disease. Normoblasts were present in three patients and megaloblasts in one. Nine patients showed slight or moderate deformity and degeneration of the erythrocytes. Leucocyte counts revealed an absence of leucopenia and a tendency to slight leucocytosis. The leucocyte count just prior to operation varied from 6,400 to 19,400 and averaged 10,950. Differential counts were not distinctly abnormal; there was an absence of lymphocytosis. After splenectomy there was as a rule a very prompt increase in the hæmoglobin estimation and the red-cell count. Post-operative leucocytosis was noted but it was not a constant finding. In a majority of the cases after splenectomy there was an increase in the relative percentage of small lymphocytes and a decrease in polymorphonuclears. The reverse has been noted in our cases of pernicious anæmia after splenectomy; that is the blood has shown an increase of polymorphonuclears.

TABLE L.—BLOOD COUNTS IN TWELVE CASES OF HEMOLYTIC JAUNDICE SPLENECTOMY

CASE	Time Before and After Splenectomy	Hb. (gms.)	RBC. (millions per cmm.)	Color Index	Normalized	Megakaryocytes	Miscellaneous Findings	WBC. (cmm.)	Platelets (cmm.)	Small Lymphocytes %	Large Lymphocytes %	Monocytes %	Eosinophils %	Neutrophils %
1	10 d. before 10 d. after	8	62	+	+			1000	75					3
2	10 d. before	8	62	+	+			1000	75					3
3	10 d. before	10	60	+	+			1000	75					3
4	10 d. before	10	60	+	+			1000	75					3
5	10 d. before	10	60	+	+			1000	75					3
6	10 d. before	10	60	+	+			1000	75					3
7	10 d. before	10	60	+	+			1000	75					3
8	10 d. before	10	60	+	+			1000	75					3
9	10 d. before	10	60	+	+			1000	75					3
10	10 d. before	10	60	+	+			1000	75					3
11	10 d. before	10	60	+	+			1000	75					3
12	10 d. before	10	60	+	+			1000	75					3

BLOOD COUNT IN FIVE CASES OF HEMOLYTIC JAUNDICE NON-OPERATIVE

13	10	10	60	+	+			1000	75					3
14	10	10	60	+	+			1000	75					3
15	10	10	60	+	+			1000	75					3
16	10	10	60	+	+			1000	75					3
17	10	10	60	+	+			1000	75					3

NOTE.—Differential are based on count of 100 cells.  
\*Number of cells seen. †Color counting 100 leukocytes.

The condition of the blood was reported as normal in nine of ten living patients from two months to five and one-half years after operation. However in only a few of these

patients has it been possible to obtain complete blood counts. In the tenth patient the hemoglobin reached 80 per cent and the erythrocytes 3,770,000 fourteen months after

TABLE II.—FRAGILITY TESTS IN HEMOLYTIC JAUNDICE

Non-Operative and Pre-Operative Cases

Case No.	Percentage of Sodium Chloride in Which Hemolysis was Complete	
	Patient	Control
1 (35045)	467	425
2 (35045)	4	34
3 (35045)	4	24
4 (35074)	44	25
5 (35125)	460	280
6 (35000)	4	20
7 (35118)	44	25
8 (35070)	4	28
9 (35075)	44	28
10 (35065)	4	26
11 (35135)	4	20
12 (35135)	4	20
13 (35135)	4	20
14 (35135)	4	20
15 (35135)	4	20
16 (35135)	4	20
17 (35135)	4	20

operation, but a relapse occurred two years after operation at which time the hemoglobin was 36 per cent and the erythrocytes 2,120,000. Improvement followed this relapse and the blood is much improved two and one-half years after operation (see Table I).

*The Riberre or fragility test.* The fragility of the red cells in the peripheral circulation to hypotonic salt solution was tested before splenectomy in all but three patients and in two of these three the clinical characteristics were so clear that there can be practically no doubt of the existence of hemolytic jaundice. The third patient showed an increased fragility when first tested twenty months after operation. In the fifteen patients tested hemolysis was complete at from 0.4 per cent to 0.48 per cent sodium chloride with the controls usually at from 0.32 to 0.36 per cent. Results in the individual cases will be seen in Table II.

There was no decided or constant decrease of fragility in the cases after splenectomy. Eight patients were tested at periods varying from fifteen days to one year and nine months following operation. Only two of these showed a normal resistance in one it was merely temporary. In none was there an increase of resistance. Table III shows representative readings.

The finding of an increased fragility of the red cells in members of the patient's family is significant. In one instance the patient's brother who also had had very mild attacks of jaundice showed a definite increase of

TABLE III.—FRAGILITY TESTS IN HEMOLYTIC JAUNDICE AFTER SPLENECTOMY

Case No.	Percentage of Sodium Chloride in Which Hemolysis was Complete		Time After Operation
	Patient	Control	
1 (3516)	4	34	year 8 months
2 (3516)	4	26	year 9 months
3 (3516)	4	26	8 days
4 (3516)	4	26	5 days
5 (3516)	4	26	3 days
6 (3516)	4	26	3 days
7 (3516)	4	26	4 months
8 (3516)	4	26	3 days
9 (3516)	4	26	3 days
10 (3516)	4	26	3 days
11 (3516)	4	26	3 days
12 (3516)	4	26	3 days
13 (3516)	4	26	3 days
14 (3516)	4	26	3 days
15 (3516)	4	26	3 days
16 (3516)	4	26	3 days
17 (3516)	4	26	3 days

fragility. In another instance the patient's mother who never had had symptoms which were in the least suggestive of hemolytic jaundice showed complete hemolysis in 0.4 per cent sodium chloride. The age of both of these patients at the onset of symptoms was 18 years suggesting that there is probably a congenital factor in some of the patients who have not had symptoms during childhood. Therefore testing members of families though there is no familial history of jaundice becomes of the utmost importance.

*Urine.* Urobilin and urobilinogen were both present in the five cases in which the urine was tested for these substances. Bile was absent in all cases save one in spite of the frequency of cholelithiasis as a complication. The diagnosis of hemolytic jaundice may be at times confused by the presence of bile in the urine when an obstructive jaundice has been superimposed upon an acholuric jaundice.

*Hæmorrhage.* Hæmatemesis and melena occurred in one instance. Epistaxis occurred in four of the seventeen patients but was never severe. The coagulation time (Boggs's coagulometer) was not increased in these patients with hæmorrhage.

*Wassermann tests.* The Wassermann tests were negative in eleven of thirteen patients tested. One patient (Case 15) was said to have had positive Wassermann tests twelve months and five months previous to examination and a Wassermann test was positive at the time of examination. There was also a history of probable infection. This case was non-operative. One brother of the

patient had a history suggestive of hemolytic jaundice. In another patient (Case 6) two Wassermann tests were positive before operation and one was negative after operation. A very careful search of the history and findings failed to reveal any evidence of infection. There was no evidence of syphilis in the spleen removed at operation. It is conceivable that syphilis might produce a condition simulating hemolytic jaundice, though I have been unable to find record of cases in which the characteristics were identical. Case 15, however, may be an example of this occurrence.

**Blood pressure.** A noticeably low blood pressure was present in all of the cases except one, the systolic frequently reading below 115. The diastolic blood pressures were consistently low, averaging 72 in sixteen cases. This hypotension occurred irrespective of the degree or absence of anemia.

**Loss of weight.** In general very little loss of weight was noted. One patient with a severe form of the acquired type of the disease, however, had lost 48 pounds.

**Gall-bladder disease.** Three of the twelve splenectomized patients in this series had been operated on formerly for gall bladder disease, probably with the expectation of curing the condition. The incidence of gall stones in the severe types of hemolytic jaundice is high, however. Seven of our twelve operative cases (58 per cent) showed gall stones for which a later operation was usually done. Removal of the gall stones in a case of hemolytic jaundice does not cure the condition, but on the other hand a patient after splenectomy may improve remarkably although retaining his gall stones. The formation of gall stones is doubtless an important incident in the course of hemolytic jaundice. The attacks of acholic crisis become more severe over a period of years and pain is added to the early syndrome of deepening jaundice, abdominal distress, fever, malaise, and headache until the pain becomes the prominent symptom and the attacks are quite typical of cholelithiasis.

**The values for hemoglobin-derived pigments in the duodenal contents (Schnneider test).** The values for urobilin and urobilinogen in the duodenal contents is doubtless an index of the

blood destruction present at a given time. There is probably a marked variation in these values according to fluctuations in the course of the disease. They are, however, quite constantly high. Twelve duodenal tests were done on six of these patients. The average in patient before splenectomy was 2050 units for urobilin and 1100 units for urobilinogen. It is probable that in a larger series the values would average higher for there is clinical evidence of active blood destruction. In two patients with very high values the blood picture simulated that of pernicious anemia, a greater degree of blood destruction evidently exhausting the bone marrow. The same four patients, tested after operation at periods varying from thirteen days to four months, showed an average of 800 units for urobilin and 625 units for urobilinogen. It will be noted that there is a very considerable decrease in the values after splenectomy and that the decrease of urobilin is proportionately more marked than that of urobilinogen. The decrease is not as marked in the early period following splenectomy for hemolytic jaundice as it is following splenectomy for pernicious anemia. The fall in urobilinogen is less marked than in those cases of pernicious anemia in which there is no definite evidence of change in the liver. Very soon after splenectomy for pernicious anemia urobilinogen falls to zero in 78 per cent of the cases. The values in one severe case of the acquired type of hemolytic jaundice with a blood picture of pernicious anemia, obtained only during a relapse one year and eight months after splenectomy, were high, showing a total of 2000 units. These values were not included in the preceding averages. This patient had a large liver with probable biliary cirrhosis (see Table IV).

**Transfusion.** I cooperative transfusions were not necessary in any of the cases of this series. One patient who returned one year and eight months after splenectomy in a relapse of anemia improved after two transfusions.

**Postoperative course.** The immediate improvement following splenectomy for hemolytic jaundice is very striking. The jaundice

TABLE IV—HÆMOLYTIC JAUNDICE

The Values for Hemoglobin-Derived Pigments in the Duodenal Content

Case No.	Time Before and After Splenectomy	Bilirubin	Urobilin	Urobilinogen	Total	Remarks
8 (350)	Year 3½ months after	+++	3000	000	4000	Acquired Estimation during relapse
8 (345)	38 days before 38 days after	+++ Trace	1800 400	000 800	1800 1200	Congenital Severe case
9 (3700)	47 days before 4 days before 8 days after 30 days after	Trace Trace	400 3000 800 Trace	000 200 000 400	400 3200 800 400+	Familial Mild case
6 (135)	3 days before 3 days after	— Trace	500 400	300	000 400	Congenital
(620-)	4 days before days after	+++ ++	400 000	800 300	1200 300	Probably congenital
3 (410)	Non-operative	+	3000	Trace	3000+	Probable familial

frequently becomes noticeably improved with in twenty four hours and may entirely disappear during the first few days. The condition of the blood likewise rapidly improves. Our first patient was operated on July 30 1911 five and one half years ago and has been in excellent condition ever since that time. She had been constantly jaundiced from infancy to the time of splenectomy and has never been jaundiced since. During the five years preceding splenectomy she had had recurring attacks of anemia but has not been anæmic since splenectomy. There was one operative death a mortality of 8+ per cent. Reports from all save two of the other patients have been uniformly good. One boy of 9 years who had an extremely large spleen and an enlarged liver together with a very severe grade of anemia has been in robust health since splenectomy. The condition of his blood improved with extreme rapidity after operation without any form of medical treatment other than hygienic care. Fifteen months after splenectomy the patient was in excellent health. The disease in the two patients who have not done so well was of the acquired type. One of them died four months after splenectomy. The other rapidly became very much improved and was in excellent health for one year and a half. She then had a relapse of both the anemia and jaundice but improved satisfactorily after two transfusions and is now in good health again. The remaining eight patients have been well for twenty three months or less (Table V).

## DISCUSSION

Hæmolytic jaundice may be regarded as the diagnostic keystone of the diseases associated with splenomegaly and anemia. In clinical significance it occupies the center of a group of diseases with cirrhoses of the liver syphilis of the liver with splenomegaly and obstructive forms of chronic jaundice on the one hand and pernicious anemia splenic anemia leukemia and splenic Hodgkin's disease on the other. An appreciation of the characteristics of hæmolytic jaundice gives a new insight into the diagnosis of these interesting diseases. The differentiation between chronic jaundice due to obstruction of larger ducts and hæmolytic jaundice (which in part may be due to obstruction of smaller ducts) depends largely on a recognition of the type of jaundice present. The jaundice of uncomplicated hæmolytic jaundice is an intensified hæmolytic icterus an exaggerated form of the icteric tinge so constantly seen in pernicious anemia. It is an acholuric jaundice there is no bile in the urine. It is not associated with pruritus. It is of a chronic nature and may be comparatively deep or of mild grade. It is usually remittent in type and never entirely disappears. In obstructive jaundice there is cholic urine and frequently acholic stool in hæmolytic jaundice acholic urine and cholic stool. The second more important distinction between obstructive jaundice and hæmolytic jaundice lies in the difference in the resistance of the erythrocytes in the peripheral circula-

Case	Age and Sex	Family History	Menstruation	System	Local	General	Weight	Height	Temperature	Date of Operation	Result	Remarks
1	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
2	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
3	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
4	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
5	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
6	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
7	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
8	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
9	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy
10	21	Not familial	Normal	Normal	Normal	Normal	120	5' 0"	98.6	10	Good	History clear for knowledge of menopause (all stages re moved) early pregnancy

## HÆMOLYTIC JAUNDICE—NON OPERATIVE

Case	Sex	Age	History	Spleen	Examination	Weight	Height	Notes
1 (1910)	M	3	1 year Acute	Moderately enlarged	Normal on examination	4	40	1 year after examina- tion general health good no jaundice and re- turn.
2 (1910)	M	3	1 year Acute	Moderately enlarged	Markedly enlarged	4	30	9 months after examina- tion health good Mild attack of jaundice.
3 (1911)	M	3	1 year Acute	Moderately enlarged	Normal on examination	4	40	Year after examination health good no jaundice no return.
4 (1911)	M	3	1 year Acute	Slightly enlarged	Slightly enlarged	4	40	6 months after examina- tion health good
5 (1911)	M	3	1 year Acute	Palpable	Normal on examination	4	40	3 months after examina- tion health good. Color improved.

Case 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

tion to hypotonic salt solution. In obstructive jaundice the resistance of the red cells is quite constantly increased—sometimes very markedly increased—while in hæmolytic jaundice it is decreased—that is the cells are more fragile. This has been found to be a congenital condition and members of the family should be tested for fragile corpuscles. In order to ascertain exact data concerning the congenital factor in a larger percentage of the cases. An increase of fragility in other members of the family may prove to be corroborative evidence to a diagnosis.

Certain types of cirrhosis of the liver with jaundice may prove to be impossible of a clinical classification. While the spleen is usually smaller in cirrhosis of the liver than in hæmolytic jaundice and the resistance of the red cells is increased, both of these criteria may be vitiated that is the spleen may be quite large and the presence of toxic substances and bile pigments may affect the resistance of the red cells. I have seen so confused a condition in the same patient as cirrhosis of the liver marked splenomegaly, cholelithiasis and a pernicious anemia type of blood picture when only a definitely increased fragility of the red cells indicated the way to a diagnosis of hæmolytic jaundice as the probable primary condition. A more baffling confusion may exist when hæmolytic jaundice has progressed through its attacks of acholic crises to typical attacks of cholelithiasis with a secondary obstructive jaundice superimposed upon the original hæmolytic jaundice. In this event, the Ribierre test for an increased fragility of the erythrocytes if positive becomes of especial importance. Increased fragility a history of former recurrent attacks of jaundice and crises together with a predominating splenomegaly and a more or less severe anemia will usually upon careful analysis serve to indicate the proper diagnosis.

Syphilis of the spleen may simulate the clinical picture of any of the other forms of the splenomegalic syndrome. An enormous spleen, deep chronic jaundice, recurrent jaundice, cirrhosis of the liver and probably even the pernicious anemia type of blood picture have each been observed as associated with



and probably a result of syphilis. I do not know of an instance however in which the exact syndrome of hæmolytic jaundice complete in all its details has been reproduced by syphilis.

The importance of obtaining a history of recurrent attacks of jaundice is exemplified in the mistake not uncommonly made of confusing hæmolytic jaundice with simple splenic anemia. The history of every patient with suspected splenic anemia should be reviewed carefully for former attacks of jaundice and crises of the acholic type. In this way only will patients with little or no jaundice at the time of examination be differentiated. Hæmolytic jaundice is always to be considered before a diagnosis of splenic anemia is made.

Pernicious anemia may simulate hæmolytic jaundice. Given a young patient with a large spleen and evidence of very active hæmolysis resulting in a moderate degree of icterus, hæmolytic jaundice would at once be suspected. The pernicious-anemia type of blood picture with high color index occasionally occurs in hæmolytic jaundice when myelotoxic features have developed and this finding further confuses the picture. It would appear that the chief reliance in these cases must be placed upon the absence of a typical history of pernicious anemia and the finding of fragile red cells. For in pernicious anemia there is not the increased fragility which is found in hæmolytic jaundice. In many cases of pernicious anemia in which the Ribierte test has been done the resistance of the erythrocytes to hypotonic salt solution has been constantly normal or increased.

Splenic Hodgkin's disease usually remains undiagnosed until surgical exploration or autopsy. The spleen is nodular and this characteristic may be possible of recognition upon physical examination. A history of the former enlargement of the lymph nodes may be obtained while the lymph glands may be small and the spleen large at the time of examination. In every case of splenomegaly the condition of the lymphatic system demands observation, and if necessary a gland should be excised for pathologic diagnosis. I have recently seen two patients with Hodg-

kin's disease who presented very large spleens and small lymphatic glands. In one of these a diagnosis was made upon the microscopic examination of an excised gland.

Leukæmia may be seen during a period when the spleen is only moderately enlarged, the anemia is severe a blood picture simulating the primary type of anemia is present, and myelocytes are absent. With any considerable enlargement of the spleen in leukæmia however the blood picture is usually though not always pathognomonic. One patient came under my observation in whom a characteristic blood picture of leukæmia was not obtained until several years after splenectomy. The case had been formerly regarded as one of splenic anemia. In a more recent case of leukæmia there was some resemblance to hæmolytic jaundice but the fragility of the erythrocytes was not increased.

A very valuable general discussion concerning the diseases associated with splenomegaly, anemia and jaundice has been published by Krumbhaar. The literature of splenectomy in the treatment of hæmolytic jaundice was summarized in 1915 by Elliott and Kanavel who were able to collect forty-eight cases. In the earliest case they found the patient was operated on by Sir Spencer Wells in 1887 and reported by Dawson twenty-seven years later as cured. The fragility of the erythrocytes in this case was still increased. A patient operated on by Bland Sutton in 1895 was well ten years later. Since the publication of the report by Elliott and Kanavel, Hellstroem has recorded two cases, Peck three and Friedman and Katz one. Including the twelve cases here discussed a total of sixty-six cases of splenectomy for hæmolytic jaundice has been reported. The surgical indications and technique of splenectomy have been elaborated by Mayo and Balfour.

#### SUMMARY

1 Seventeen cases of hæmolytic jaundice are reviewed of which four are probably of the acquired type. In twelve of them splenectomy was performed.

2 An increased fragility of the erythrocytes in the peripheral circulation was a constant finding in all the fifteen patients

tested. This increased fragility was found to persist at varying periods after splenectomy in seven of eight patients tested.

3. The values for urobilin and urobilinogen in the duodenal contents were high in six patients in whom they were estimated. There was an appreciable fall in these values following splenectomy.

4. In seven (58 per cent) of twelve splenectomized patients gall stones were present. The removal of gall stones has not cured hemolytic jaundice. On the other hand patients with hemolytic jaundice who were splenectomized have been cured of their jaundice and anemia though retaining the gall stones.

5. Of the twelve patients on whom splenectomy was performed ten are living, nine are in excellent health without jaundice or anemia. There was one operative death. One patient died four months after operation, another patient with a severe form of the acquired type of the disease was in excellent health for eighteen months, had a relapse after two years and is again in fairly good health after two and one-half years following two

transfusions. Four patients have been in excellent health for fourteen months, fifteen months, twenty three months and five and one half years respectively.

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## PERFORATIONS OF GASTRIC AND DUODENAL ULCERS

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THAT ulcers of the stomach and duodenum frequently destroy all the coats does not seem strange when one considers the thin walls of these viscera. According to the best statistics obtainable 20 per cent of the duodenal ulcers sooner or later perforate while perforation occurs in only about 7 per cent of the gastric ulcers. Why perforations should be three times as likely to occur in duodenal than in gastric ulcer is not clear. It does not seem reasonable that it is entirely due to the thinner wall. The apparently greater tendency for infiltration and thickening of the base of a gastric ulcer may give it greater immunity.

It is desired to limit the latitude of this paper to a consideration of so-called acute perforation. These are almost all fatal unless an early diagnosis is made and proper treatment carried out before the resulting peritonitis is too far advanced. It is fortunate that most of these perforations are in the anterior wall of the stomach and in the more accessible portions of the duodenum.

In so acute and serious a condition where prompt operation is all important it is bad practice to load up with a multiplicity of diagnostic signs which are time-consuming burdensome to a suffering patient and not of very much consequence anyway. Among the diagnostic points then only those of capital importance and those that can easily be made use of at the bedside without waste of time will be considered.

The onset is always sudden, the course rapid and unless a timely operation is done there is inevitably a fatal ending. Uppermost in one's mind should be kept the fact that this calamity must be met promptly with the best proved methods and that each hour's delay will be penalized by the loss of a definite percentage to the operative chances.

After learning of the sudden onset of pain if carefully questioned the patient will usually give a history of previous gastric symptoms and will often describe a feeling of increased

discomfort and vague stitchlike pains in the upper abdomen lasting several hours or even days before the storm burst. These symptoms are probably due to the fact that the ulcer had penetrated to the peritoneal coat and produced a localized irritation or inflammation of the peritoneum at the site of the impending perforation. At this stage, when the benevolent omentum drops over the irritated spot and adheres a so-called chronic perforation occurs and acute perforation is prevented. Or if instead of the omentum a wide awake surgeon should happen along learn of the increase in intensity of the symptom and rightly interpret them, advise an immediate operation and have the advice accepted he could forestall the perforation. Although such a contingency is not to be looked for every day it is conceivable and would avert a serious calamity.

The first symptom of perforation is sudden acute agonizing unendurable pain. The patient lies absolutely still because every movement increases his pain. Every one I have questioned on this point has said that he had never before conceived that such extreme torture could be. He scarcely dares breathe for even ordinary respiration increases the pain. The tense motionless attitude is in marked contrast to the extreme restlessness of one suffering from severe colic, whether it be renal, intestinal or hepatic, for these conditions are marked by continual changes of position with the hope of getting relief. The torture from a perforating gastric or duodenal ulcer seems several degrees greater than that from a perforation of the gall bladder or the appendix. This is probably accounted for by the acid gastric juice coming in contact with the peritoneum.

Almost immediately after the perforation the abdominal muscles become intensely rigid. The boardlike rigidity is so great that one might stand on the abdomen and make no impression on the tensely contracted muscles. During the first few hours

the rigidity if it be possible is even greater over the site of the perforation than over the other regions of the body though this is comparing a superlative with another superlative. In the beginning pressure over the seat of the lesion elicits more exquisiteness of tenderness than in other places.

The early pain of perforating gastric ulcer is much the same as that from perforation of the duodenum. After an hour or two there are one or two points of distinct difference. The pain and tenderness following the perforation of an anterior gastric ulcer is more general over the abdomen especially in the central and left abdomen due to the more general soiling of the peritoneum by the pouring out of the gastric contents.

On the contrary the fluid passing through a perforation of the duodenum is carried along the trough of the transverse colon toward the right around the hepatic flexure and down along the outer side of the ascending colon to the right iliac fossa. And thus it is often found in an hour or two after perforation of a duodenal ulcer the greatest point of tenderness appears to be in the region of the appendix. For this reason a preoperative diagnosis of ruptured appendix is common. In two of my own cases this error was made. It is an awkward mistake and necessitates an additional incision or an unnecessarily long incision when the appendiceal wound is extended upward.

Greater care in eliciting the anamnesis and a patient effort to learn the exact location of the primary pain will often make it possible to avoid such an error. It is rare that perforation of the appendix occurs without some preliminary symptoms in the right iliac fossa.

After perforation of a gastric or duodenal ulcer only a few hours will elapse before the symptoms become those of general peritonitis. Most of my cases had reached this stage before I had an opportunity to examine them. After the onset of peritonitis the pain and tenderness are so general and the tenderness at the seat of perforation so nearly the same as that all over the abdomen that little knowledge of the primary lesion can be gained by examination at this time. If a correct diagnosis is made when the patient is not

seen until the advent of general peritonitis it must depend on the location of the first pain its intensity and the history of the case before the perforation occurred.

If ideal conditions obtain the diagnosis will be made and operation done before the onset of general peritonitis. At this time the diagnosis is easier and more likely to be accurate and the chances of successful operation are much better. Every hour that elapses after the perforation adds to the mortality. Unfortunately many of these cases are not operated upon until the peritonitis is well advanced. It would be better to be operated upon by a sensible surgeon of only limited experience within six hours after a perforation than by the best surgeon in the United States twenty four hours later.

Whether it is possible to make a definite preoperative diagnosis or not, it is always apparent that a serious intra abdominal calamity has occurred and the indications cry out loudly for an immediate operation. When this call is not heeded the attendant takes upon himself a burden of responsibility too heavy for any man to carry.

Careful but rapid preparations should be made preferably in a hospital but in the patient's home if the hospital is too far away. The incision is made high up to the right of the median line or in the median line if the greatest tenderness is there. Gastric or duodenal leakage usually leads one at once to the seat of the perforation where gas and duodenal or gastric contents can be seen to be seeping out.

The point on which there is the greatest disagreement is how much or how little shall be done. Shall the perforation be sutured in the simplest manner possible and the operation end there? Shall the perforation and ulcer be so thoroughly turned in with superimposed sutures that it produces narrowing of the outlet of the stomach? Shall the ulcer be excised? Shall an omental graft be used? Shall gastro-enterostomy be done? Shall drainage be used in every case and how?

Hard and fast rules will never apply in lesions of this kind. For best results the type of operation will have to conform to the pathology found. When the operation is

done early before peritonitis has developed the procedure will never be the same as in the cases of advanced peritonitis.

When the operation is early it can at least approximately conform to the method followed in an ordinary ulcer with stenosis such as the surgeon is so frequently called upon to perform. In such a case the thorough turning in of the ulcer with sutures to the degree of as nearly as possible obliterating the outlet of the stomach is a reasonable procedure. To make assurance doubly sure I like to overlap the gastrohepatic omentum and the right border of the great omentum over the line of suture and hold them there with one or two sutures. If the perforation is very recent and the ulcer can be excised without too much additional risk and the wound closed and covered as before it is still better.

This latter procedure commends itself not only from a natural desire to get rid of the pathology and render improbable another perforation but to minimize the chance of cancer developing in the border of an imperfectly healed ulcer. In either event the next logical step is to perform a posterior gastro-enterostomy, the opening in the stomach being made as near the pylorus as practicable.

If the perforation is on the anterior wall of the stomach away from the pylorus excising of the ulcer or turning it in is all that is necessary. Gastro-enterostomy in such a case will serve no useful purpose. If the perforation is in the posterior wall of the stomach it can usually be sutured from behind either working through a slit in the transverse mesocolon or sometimes through a slit in the lesser omentum.

Should the operation be done very early and the leakage found to have been very slight I can conceive that it might be proper to close the abdominal wound without drainage. Personally I have never done this because I have feared to do so. In the few cases operated upon early there has always been enough leakage to make me fear the consequences of complete closure of the abdomen. In some cases the original wound has been closed and only drainage of the cul

de-sac made use of keeping the patient in the Fowler position.

Even in cases with a very young peritonitis the method already described can safely be employed. The more advanced the peritonitis the more a gastro-enterostomy to be feared. Inflamed and infected peritoneum is very prone not to heal kindly. The more advanced the peritonitis the less likely is it to heal promptly and perfectly. Furthermore when the peritonitis is far advanced and the vitality of the patient reduced his ability to withstand the more prolonged operation is greatly lessened.

It is my conviction that in late operations the less we do besides stopping the leak and establishing adequate drainage the better. Simple suture of the perforation in a direction to produce the least possible narrowing of the stomach outlet and covering the site of the perforation with an omental graft is quickly done. Even though a gastro-enterostomy has to be performed later it can be done much more safely after the peritonitis is relieved. I am very much in favor of doing the operation in two stages rather than subjecting the patient to unnecessary danger by doing the more complete operation when he is in such poor condition to stand it. Many of these cases will not require a subsequent gastro-enterostomy if undue narrowing of the stomach outlet is avoided.

The manner of draining is of the utmost importance. Poorly placed and badly chosen drains have cost many lives. If the operation is fairly early drainage at the site of perforation is not always necessary. A large rubber tube not too hard but not too easily collapsible introduced through a stab wound above the pubes and accurately placed at the bottom of Douglas cul de sac by a guiding hand in the abdomen and kept syphoned out is sometimes all the drainage required.

In the majority of cases greater safety seems to lie in additional drainage in the region of the perforation. A split rubber tube containing a roll of gauze or a cigarette drain the size of the tube or cigarette drain depending on the amount of the pathology seems to be much better than more massive drainage. Unless the perforation is exceed-

ingly minute and the leakage practically nil I should not be satisfied without the tube in the cul de sac whether the primary wound is drained or not.

There seems to be more or less difference of opinion with reference to the best disposition to be made of the migrated gastric contents and the inflammatory products resulting from the peritonitis. I can only give my own method and the reasons for it. I never irrigate the peritoneal cavity under any circumstances. If the operation is early before peritonitis has begun or before it has become general irrigation is bound to carry gastric contents or infective material to portions of the peritoneal cavity not yet involved. It converts a local trouble into a general one.

When peritonitis starts nature immediately begins its benign work by throwing out an exudate on the peritoneal surface of fibrin and leucocytes which with the serum form a film of protection which prevents rapid absorption of the toxins and micro-organisms and safeguards the body against an overwhelming toxæmia or infection. Irrigation no matter how gently done washes away this

protecting film opening the avenues of absorption. I have seen such acute toxæmia follow irrigation that a fatal issue resulted in a few hours.

I make no great effort to get rid of the peritoneal débris. Wiping it away is almost as bad as irrigation. If gross particles show themselves they may be gently picked away or dipped out with a large spoon or soup ladle. Sometimes a pool of foul material may be sopped up with a large gauze sponge wet in normal salt solution. The gauze should never rub or wipe.

After the operation with drainage of the cul-de sac, the Fowler position and the Murphy method of using salt solution per rectum there will be a sufficient current of serum in the direction of the cul-de sac to pretty thoroughly clear away the débris within a few hours. The peritoneum is able to so far disintegrate any gross particles that they are easily carried along by the current. It is so gently done that no violence is done the peritoneum as would have happened by irrigation or sponging in too great eagerness to secure an ideal peritoneal toilet.

PERITONEAL ADHESIONS<sup>1</sup>

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**P**ERITONEAL adhesions are relics of past peritonitis or are a result following mechanical or chemical trauma.

They represent a conservative reaction on the part of the animal economy and all are essentially benign in their intent. Should the formation of peritoneal adhesions be inhibited both abdominal surgery and recovery from intraperitoneal infection would be unheard of. The peritoneal adhesion has a mission to perform and only when its function is exaggerated or perverted does it become an undesirable factor. Therefore the purpose of the research surgeon does not seem to point to their prevention but rather to attain a better understanding of their natural history and to suggest means of turning them to useful purposes.

The attempt to prevent the formation of adhesions by inhibiting fibrin formation with the use of citrate phosphorus or peptone while it may for a time postpone scar tissue formation, does not seem advisable for the following reasons. The use of citrate particularly makes the control of hemorrhage difficult and according to Sweet, Chaney and Wilson it tends to disseminate infection and interferes with repair. In case of survival of the animal it does not always prevent adhesions. The modification of the citrate method as suggested by Pope by using it on gauze packing seems an unsatisfactory compromise. In many instances too much energy is wasted in attempts to cure adhesions by the knife. Therefore this paper will discuss the causes of adhesions, the natural course of development of an adhesion if it is possible to permit of its development and finally what surgery can do to relieve the symptoms that come from adhesions by controlling the direction of their occurrence.

Before attempting these problems one must know the character of adhesions. Under the term adhesion a great variety of

pathology is included. In the broadest sense the term adhesion includes everything from peritoneal agglutination to the true adhesions made up of connective tissue with definitely organized blood vessels. For practical purposes an adhesion is a definite organization of scar tissue between two or more structures. In addition, we may have scar tissue in the visceral peritoneum without adherence to any other structure. This may be demonstrated by gauze stripping of the intestine with almost the same results obtained by Wegner who studied the changes in the endothelium of the peritoneum after trauma with air blast. These changes range from fatty degeneration of endothelium with subsequent desquamative change to ultimate connective tissue replacement.

Hertzel has shown that limited destruction of endothelium resulted in agglutination but when the trauma reached to the sub-endothelial connective tissue true scar tissue proliferation took place together with vascularization. Hertzel emphasized the important rôle of inhibition of peristalsis in the statement that irritation of an intestinal wall with the point of a needle after primary increase of peristalsis is followed by a lessened peristalsis. Following the temporary paralysis the adhesion occurs. The first step in the formation of the adhesion is exudation of serum and change in the endothelial cells. The exudated serum coagulates and forms fibrin particularly at the edge of the process. At the same time that the fibrin formation is taking place polynuclear leucocytes escape into the coagulated mass. Within a few hours round cells collect in the fibrin mass. At this time the fibers of the basement membrane begin to loosen and different fibers become entangled with those of the opposing layer of peritoneum. The fibrin formation at the beginning appears to remain and serve as a scaffolding for the subsequent process.

Clinically as well as experimentally it has been our observation that there seems to be a direct ratio between the amount of fluid in the inflammatory exudate and the density of the subsequent adhesion. Hertzler calls attention to the greater tendency to adhesions to form subsequent to operative procedure on the lower ileum as contrasted to the jejunum. This probably is a result of the difference in bacterial flora of the upper and lower bowel. It has been my observation in some 200 intestinal anastomoses that any invasion of the lower bowel was almost sure to be followed by adhesions while the jejunum and duodenum could often be entered without any such consequence.

The causes of adhesions are given by Murphy as chemical or mechanical irritation or infection. For purposes of presentation we will first consider the rôle of aseptic trauma. From our own work the etiological significance of pure uninfected trauma seems to dwindle. When taken in connection with infection no one can doubt the importance of this element. All of our experiments emphasize the importance of the traumatic factor when taken in conjunction with infection but minimize it *per se*.

To determine the effect of sterile trauma a series of experiments were undertaken. Sterile section of the abdomen was done in a series of dogs. In these animals the parietal peritoneum and the peritoneal coat of the ileum were abraded with gauze until they bled. The laparotomy wounds were then closed and the animals allowed to recover for varying periods of time. At the autopsies there were seldom any adhesions either to the omentum or viscera. The peritoneum usually was found glistening and of normal appearance. Microscopic section showed normal investment with endothelial layer. The visceral peritoneum did not present the same appearance. While there were no adhesions between the viscera yet the peritoneum over the ileum often showed patches of scar tissue. These results were somewhat analogous to those of Dembousky who traumatized by means of a sterile toothbrush. Vogel results with cautery were accompanied with no marked adhesions but were not

identical in that superficial cauterization did produce adhesions while black burns did not. Sanger's experiments where 6 centimeter defects in the peritoneal wall of dogs had been produced naturally resulted in adhesions. These so often quoted can hardly be used as an illustration of ordinary mechanical traumatism. However other observers have found that even stripping the parietal peritoneum did not often cause adhesions if the work was done aseptically. Sterile gauze when left in the wound undoubtedly causes adhesions.

The use of catgut has been acquitted of the charge of producing adhesions. Yet it is true that linen sutures produce typical anatomical adhesions. A series of experiments were done with adhesions produced by continuous linen suture and these were studied to determine something of the life history of an adhesion. For this purpose two opposing peritoneal surfaces of the ileum were sewed together with linen. The sutures reached only to the muscularis and were very carefully placed. After such an experiment, at the end of two weeks the line of suture was densely adherent. Histologically the adhesions differed from no other adhesions. As these animals were repeatedly subjected to laparotomies it was found that the adhesions stretched out and finally disappeared. This occurrence had its counterpart in adhesions from other causes but this method was used in that it offered a means of accurately recording the changes that took place and that it permitted measurement in centimeters. On the other hand, the changes in unlimited adhesions or the changes in adhesions from infection could not be accurately recorded but were a matter of memory and judgment. Therefore this type of adhesion is used in detailing the natural history of these structures. As the adhesions stretched out their blood supply became less and less and to this was attributed their disappearance. Clinically we know that the victim of painful adhesions is only relieved temporarily by operation that the trouble is very apt to return and that he may recover if these adhesions are left to their own natural life cycle. These same



uture lines when disturbed by attempts to break them up would be followed by increased production of new adhesion. However we sometimes find that suture adhesions do not disappear. Usually in these cases the omentum is found plastered to the suture line. The persistence of these adhesions can be explained on the ground of blood supply as this is usually deficient in adhesions. The omentum readily furnishes surrounding viscera with a new blood supply. Therefore aseptic trauma of normal parietal and visceral peritoneum does not seem to be followed by permanent adhesions unless the cohesion is augmented by the omentum.

In connection with sterile trauma F. P. Quinn has given a very important contribution to the prevention of adhesions. Part of his work was clinical observation and part of it a series of experiments carried out at the University of Minnesota. In his experimental work the parietal peritoneum was massaged by a toothbrush and the results noted in animals where both sides of the peritoneum had been so treated adhesions were the rule only on the side where the intercostal nerves had been sectioned. Moreover in some of his experiments that we repeated we found that defects in the parietal peritoneum did not cover with endothelium when the intercostal nerves had been sectioned. Further than this in many of our right rectal incisions where several of the nerves had been cut we found adhesions that were limited to the denervated area. Therefore nerve supply seems an important factor in the production of adhesions. Infection alone in our series did not produce as severe adhesions as occurred in infection plus trauma.

Much stress has been laid on the importance of good surgical technique in avoiding adhesions. Wegner and Walthards have shown the deleterious effect of drying of the peritoneum hence the value of rapid operating. Thompson has shown the effects of dry gauze left in the tissues. Moore has warned against drainage tubes in that they give access of extraneous infection to wounds. Therefore drainage should be done only when absolutely necessary. Crile and Carrel have demonstrated the value of delicate handling and the

necessity of avoiding all unnecessary gauze manipulation together with the value of perfect hæmostasis. Strassman has called our attention to the effect of hæmatoma in producing adhesions and the futility of pedicle stumps has been epitomized by Stimson. Their predilection to cause adhesion is a matter of common observation.

All of this is so familiar that the repetition is banal but the handling of the infective agent *per se* is usually left to itself and has received but little consideration by the experimental surgeon. I do not wish to minimize the importance of technique but to emphasize the importance of infection in cases where both infection and trauma are combined.

Operation often have to be done in the presence of infection already in the peritoneal cavity or infected hollow viscera have to be invaded. The density of adhesions with any standard operation carefully performed with due regard to the principles of operative surgery seem to be usually in direct proportion to the amount and character of the infective agent. For instance in intestinal work the result depends very largely on the flora of the particular region and the amount of that flora that is allowed access to the peritoneum. The important etiological rôle of infection in producing adhesions suggests the necessity for some effort to combat infection in the peritoneal cavity. So far the efforts of the surgeon have been directed more toward selecting the proper time for operation to selecting advisable routes to the seat of infection and to the refinements of technique rather than to combating infection directly. Besides this advantage has been taken of acquired immunity but very little has been done in regard to chemical disinfection. Some substances have been tried and condemned others are yet on trial. Tincture of iodine recently advocated by Crisler does not seem to be generally accepted. With our work a 2 per cent solution of iodine painted on the infected peritoneum did not always produce adhesions but the 1:5 and 7 per cent always did. Carbolic acid, salicylic acid and bichloride of mercury have all been justly condemned except when



Fig 1

Fig 2

Fig 1 Specimen 976 Illustration of tendency adhesions have to disappear Two surfaces of intestine were scratched with needle point in straight line, and sutured along line with fine sutures reaching into muscularia. These examined soon after operation showed dense adhesions along suture line At autopsy these had completely separated.

Fig 2 Specimen 977 Illustration of tendency adhesions have to disappear spontaneously Two surfaces of intestine were scratched with needle point in straight line



Fig 3

and sutured along line with fine suture reaching into muscularia These examined soon after operation showed dense adhesions along suture line At autopsy these had begun to separate Operation May 30 1906 Autopsy September 7 1906

Fig 3 Specimen 984 Repair by formation of scar tissue without adhesion in visceral peritoneum Both parietal and visceral peritoneum had been abraded with gauze until bleeding occurred Operation September 25 1906 Autopsy October 6 1906

used to sterilize minute pedicles Normal salt solution in the peritoneal cavity has been recently championed by Clark and certain experimental evidence has been produced to show that animals are less subject to peritonitis when the inoculating material was diluted with normal salt than when not so diluted The use of saline as a lavage has had but little effect in lessening peritonitis as evidenced by postoperative adhesions in our hands All of the strong antiseptics seem to do harm in the peritoneal cavity and to intensify peritonitis rather than inhibit it Ether alone offers a possible exception Hertzler produced adhesions with ether in the peritoneal cavity For that reason and for its toxic effect skepticism in the use of that agent is justified However ether in our laboratory has not produced permanent adhesions when used alone in the cavity Clinical usage has promoted the use of ether in combating peritoneal infection This might be interpreted as meaning the prevention of adhesions This has received attention from Souligoux and Morestin Reports favorable to its use appear by De Tarnowsky Dergnanc, Waterhouse Phipps and Tartois and finally by Lundholm

In the experimental laboratory the use of ether following escape of infective material on to the peritoneum does seem to lessen the formation of adhesions To demonstrate this with the idea of eliminating as far as possible the question of complicated technique a series of animal experiments was done In these experiments a hole was made in the lower ileum and the contents of the bowel allowed to escape Then the hole was closed and the infectious matter was washed out with ether Some ether was allowed to remain in the cavity As a result of these experiments general adhesions were found absent and oftentimes only a little of the omentum had attached to the bowel sutures Some of these experiments with ether were followed by adhesions These usually presented a stretched out appearance It is true that in some of the controls where ether was not used the adhesions were no more dense but this was not the rule Guy rope adhesions seemed to be more common after the use of ether than without it In some instances ether seemed to prevent adhesions in other instances at least to mitigate them In addition to this with intestinal anastomoses fewer adhesions developed as a rule after



Fig. 4

Fig. 4. Specimen of adhesion filling hematomatous mesentery. Hematomatous mesentery of the mesentery of the small bowel. It was found in the top of the mesentery that both of these had formed adhesions.

Fig. 5. Specimen of the cure of adhesion the half. This small had many adhesions but was able to move freely about. A specimen of one turn the result of full testicular anastomosis (in September 1892) the re-separated sharply if

the use of ether lavage than did without it. It is difficult to substantiate the claim that either an antiseptic of sufficient power to destroy infection. Ether is usually vaporized in the peritoneal cavity after a very short time. Test tube experiment by Topley with agar cultures required a three hour contact with ether vapor to kill bacilli coli and streptococci while the staphylococci required five hours. On the other hand suspension in liquid ether practically destroyed the bacilli coli after one minute shaking. As to the advisability of the use of ether Saliba reports favorably on its use in 40 cases of peritonitis. In this series ether poisoning was encountered twice and one of the cases



Fig. 6. Specimen of importance of repair of denuded peritoneum. It is left section taken to show repair of peritoneum over defect made peritoneum with toothbrush. Presence of infection here



Fig. 5

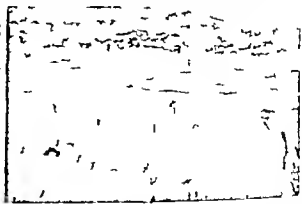


Fig. 6

Section in the plot shows condition October 23, 1905. It is left.

Fig. 7. Specimen of the effect of cutting later testicular nerves on repair of peritoneum. Analogous to section of nerves right in the section. Ovarian experiment. After removal Peritoneum scarified on either side. It tested blood dry and handled like gauze. The section of the nerves cut on one side. On 11th April 1905. A topography of 20, 1905. Adhesion limited to the nerves of peritoneum.

cocci while the staphylococci required five hours. On the other hand suspension in liquid ether practically destroyed the bacilli coli after one minute shaking. As to the advisability of the use of ether Saliba reports favorably on its use in 40 cases of peritonitis. In this series ether poisoning was encountered twice and one of the cases



B

Nerves this is left. It is left. B section taken to show back of repair of peritoneum over defect made in peritoneum with toothbrush. Presence of infection here this are had been denervated.

was complicated by pneumonia. Waterhouse has reported 60 cases with 2 of ether poisoning and 2 of pneumonia. The work of these men has established the proper dose of ether in the peritoneal cavity. It should never be more than half an ounce for children under two years and three ounces in adults. Larger doses produce ether poisoning.

In combating infection some mention must be made of the cautery. Cautery burns if properly made do not produce adhesions and the cautery is justified whenever it is possible to use it in cutting through infected tissues.

Sterile blood is ordinarily very rapidly absorbed from the peritoneal cavity without clotting as is shown by Hertzler. The rate of absorption has been shown by Buxton and Torrey. However infected blood does not act in this manner and Hertzler states that blood-clots are not so benign. In our experiments when sterile blood or even blood clots were allowed to remain in the abdomen marked adhesions did not follow. However hæmatomata in the mesentery of the bowel almost invariably were followed by dense adhesions. To illustrate that a simple needle puncture was made in the mesenteric vessel and hæmatomata allowed to form. No hæmorrhage except gentle pressure was employed. Invariably subsequent section showed these hæmatomata to be definitely attached to some surrounding structure. Strassman has also considered hæmatomata as predisposing to adhesions.

The omentum may perform a benign function or an unfavorable one. Neuhof and Wiener have shown that the omentum and particularly the free edge of the omentum has the power of being insinuated in needle hole punctures and finding attachment there. They also found that the free uncut edge of the omentum had a predilection to cover any raw or infected surface. This is benign in preventing adhesions between viscera and to the parietal wall or at least has the advantage of making them more mobile. However in cases when the omentum attaches lower down in the pelvic region it may produce trouble by traction on the transverse colon. This emphasizes the necessity of

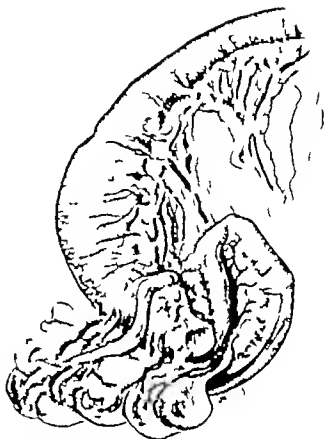


Fig. 8 Specimen 989. A piece of celloidin membrane was wrapped about bowel. Note adhesion and partial intestinal obstruction.

utilizing the omentum to advantage so that it may cover raw surfaces without extra traction. Clark has called attention to certain important facts in selecting the field for our adhesions to occur. Clark emphasizes these principles. Traction on the omentum may drag down the colon or the pyloric end of the stomach or convert the superior mesenteric artery into a constricting band. The resulting deformities cause symptoms. Further adhesions near the small bowel except at the duodenal junction and at the pelvic portion of the ileum are not likely to produce symptoms. Kinking or adhesions of the large bowel to the parietes or adhesions of the small bowel to the parietal peritoneum are capable of producing symptoms. This partly answers the question of the advantage of postural treatment during convalescence. In addition if the organs must be fixed there seems to be some advantage in fixing them in such a position that pain will not



Fig. 9. Specimen showing the separation of the omentum from the abdominal wall. The omentum is shown in the upper part of the specimen, and the abdominal wall is shown in the lower part.

Fig. 10. Specimen showing the use of the peritoneal omentum in the repair of a peritoneal defect. The omentum is shown in the upper part of the specimen, and the peritoneal defect is shown in the lower part.

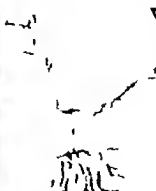


Fig. 11. Specimen showing the use of the peritoneal omentum in the repair of a peritoneal defect. The omentum is shown in the upper part of the specimen, and the peritoneal defect is shown in the lower part.

occur when the patient is standing. The Fowler position in a measure accomplishes this and in addition Clark advocates weighting down the sigmoid and the rectum with fluid. When adhesions are unavoidable we may gain much for the patient by selecting the proper site for them. This is emphasized by Reichelderfer in postural treatment. In support of this he cites a case of a girl who had been operated upon ten times for adhesions. He directed his effort toward postural localization of adhesions accomplished by allowing the patient to convalesce in the sitting position. After her last operation she was free of any unpleasant symptom.

The utilization of the omentum is desirable if it can be done without producing traction. Therefore the free omental graft first described by Senn and later in full development treated by Freeman and Mann commends itself. To determine the exact fate of the transplanted omental graft Dr. John Halgren of the University of Minnesota conducted a series of experiments. These were awarded the prize in surgery but have not as yet been published. Halgren's studies showed that the omentum could be transplanted that the transplanted omentum

gave up its fat and finally became a mass of connective tissue. The mental transplant did not give a smooth peritoneal surface in any case. Adhesion about the transplanted omentum invariably occurred but they were benign adhesions in that they were mobile and never caused obstruction or traction on painful structures such as the parietal peritoneum or mesentery. He further found that their use in the presence of infection is undesirable as loosening of the entire mass will occur. Therefore their use seems limited to covering raw surface and to give mobile adhesions between anatomical structures. The use of the omental graft seemed very superior to the use of other substances such as Cargile membrane or Pringle's celloidum membrane. Both of these substances produced adhesions and in the presence of infection greatly augmented the infection. Craig and Ellis after experimental work do not approve of the same.

Oil in any of its form does not seem to prevent adhesion except when it is used as a covering to silk packing material. Sweet after careful investigation has objected to oil in that it seems to disturb the function of the leucocytes. Gellhorn, Blake, Claypool and Wilke have given various explanations

for failure of some particular oil but do not agree as to what the proper substance may be.

I wish to acknowledge the assistance that Mr A D Hawkins has rendered me in performing some of the special experiments.

### CONCLUSIONS

1 Adhesions are benign in their intent but may become perverted.

2 Adhesions if left alone tend to disappear spontaneously.

3 Of the various etiological factors in infections seems to be the most important.

4 Trauma intensifies the effect of infection.

5 Ether seems to be the most satisfactory chemical means of combating infection. It is not devoid of danger and is not always effective.

6 Iostural treatment is an important question in minimizing the symptoms of adhesions.

7 Omental grafts may be used in covering raw surfaces but should never be used in the presence of infection.

8 The use of citrate and oil does not seem to be justified.

9 Foreign bodies such as Cargile's membrane in themselves produce adhesions and oftentimes very undesirable adhesions.

10 Hæmatomata are a cause of adhesions.

11 The cautery is a useful agent in preventing adhesions.

12 Section of nerves as may occur in the right rectus incision predispose to adhesions.

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WEBS AND POUCHES OF THE OESOPHAGUS, THEIR DIAGNOSIS AND TREATMENT<sup>1</sup>

By HARRIS PHYTON MOSHER M.D. F.A.C.S. BOSTON

THE following paper on webs and pouches of the oesophagus is mainly clinical and so lacks the measured and regular steps leading up to a foregone conclusion of academic writings. But little will be said on the etiology of these conditions because but little is known and the anatomical description of the upper end of the oesophagus will be summarized rather than given in detail. Perhaps the chief reason for writing the paper is to put on record a method of treating oesophageal pouches by cutting the common wall between the pouch and the oesophagus. As far as I know this is a new operation. It has worked well in three cases.

Pouches and webs of the oesophagus while not common are not excessively rare. In the past fifteen years I have seen perhaps seven cases of webs of the oesophagus and

some ten cases of pouch. In the past twelve months I have had three oesophageal pouches all of which have been cut. I have limited myself to these two diseases of the upper end of the oesophagus in spite of the fact that at this point they are not so common as stricture or malignant disease. Malignant disease is generally inoperable and is a discouraging and ghastly subject. We have long known how to deal with strictures.

## ANATOMY

The chief point in the anatomy of the upper end of the oesophagus for our present purposes is the fact that the outer or longitudinal coat of the oesophagus splits into two vertical bundles on the posterior surface of the oesophagus a short distance below the cricoid cartilage. These two bundles diverge leaving a V shaped space between and then turn around the sides of the upper part of the oesophagus to gain an attachment anteriorly on the median raphe of the body of the cricoid cartilage. This V shaped space is

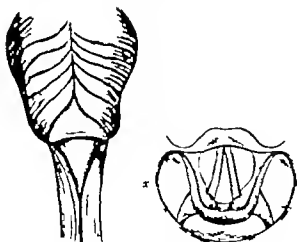


Fig. 1



Fig. 2

Fig. 1. Drawing 1 shows the posterior surface of the inferior constrictor muscle and of the upper part of the oesophagus. Triangular weak area (x) at the upper part of the oesophagus.

Fig. 2. Diagrammatic drawing showing two symmetrical webs in the pyriform fossae. Each web springs from the back of the cricoid cartilage about a quarter of an inch below the arytenoid cartilage. At the level of the lower edge of the cricoid cartilage there was an annular stricture with a central lumen a quarter of an inch in each diameter. The etiology of the webs and the stricture in this case was diphtheria.

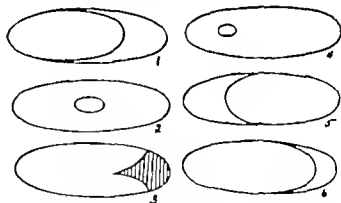


Fig. 3. Diagrammatic drawing showing webs of the oesophagus. 1. A small crescentic web springing from the right side of the oesophagus. 2. A nearly complete web with a small central perforation. The drawings in the right column are from a case which had three webs back of the cricoid cartilage the first nearly filling the lumen of the oesophagus. The small opening was placed to the left of the median line. On dividing this web a smaller crescentic web 3 was found on the left side of the oesophagus. Below this there was a smaller and third web. 4. Triangular area which results after a web such as is shown in 6 is divided.





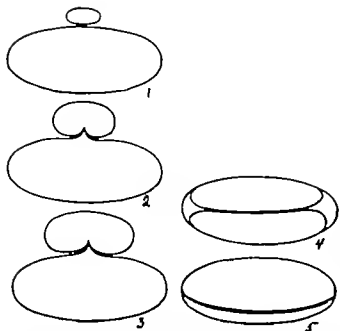


Fig. 8 Diagrammatic drawing to show the effect of cutting the common wall between the oesophagus and an oesophageal pouch. These pictures are obtained through the oesophagoscope. 1 Shows the small opening of the oesophagus anteriorly and the large opening of the pouch posteriorly. 2 Shows the lumen of the oesophagus becoming wider after the first cut in the common wall. 3 Shows the lumen of the oesophagus as it is becoming still wider after the second cut. 4. After liberal incision of the common wall, the lumen of the oesophagus and the pouch become of the same size, and the common wall stretches across the lumen of the oesophagoscope as shown in the figure. 5 In this figure the common wall has been cut to within a quarter of an inch of the bottom of the pouch. The cutting is stopped here for fear of opening the posterior mediastinum. Cutting to this point completes the operation. The common wall has gradually drawn nearer the posterior wall of the pouch until as in this diagram it is almost in contact with it. By ballooning and examining with a probe it is easy to make out just how much of the pouch has remained uncut.

history of diphtheria when she was 14 years old, followed by paralysis of the palate. Small webs like these are in my opinion commoner than we suppose. I feel that a large percentage of cases of globus hystericus are webs. The old fashioned blind passage of a bougie in these cases cured the patient by breaking the web. The modern dictum is that all cases of difficulty in swallowing should be examined with the oesophagoscope. Webs are due to scar tissue which forms on an abrasion caused by trauma or by any disease which, like pneumonia diphtheria typhoid fever or pemphigus may produce ulceration of the pharynx or oesophagus. Years ago I had one case of narrowing of the whole length of

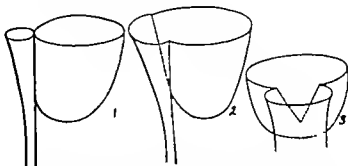


Fig. 9 Diagrammatic drawing to show the result of cutting the common wall between an oesophageal pouch and the oesophagus. 1 An oesophageal pouch with its large lumen and the oesophagus with the small opening which the oesophagus has when associated with a pouch. 2 The effect of cutting two-thirds of the common wall between the pouch and the oesophagus (seen from the side). 3 The effect of cutting the common wall between the oesophageal pouch and the oesophagus (seen from the front).

the oesophagus in a patient who during an attack of pneumonia, suffered from extensive ulcerations of the mouth and pharynx. One case in which a large web of the upper part of the oesophagus was found gave a history of typhoid fever six years before and still another case of web gave a history of diphtheria. Ulcerations produced by the burn of hot food and the bruise caused by the temporary lodging of a sharp bone might start a web. In my cases the webs have varied in size from an insignificant triangular fold to those sweeping across two-thirds the lumen of the oesophagus. I have had one web which took the form of a thin diaphragm with a central opening, and one case in which the first web was followed by two smaller webs one right and one left and all three placed behind the cricoid cartilage. The first and third webs were on the right and the second on the left. The first was the largest, the second smaller than the first and third the smallest of all.

**Symptoms** A small web may give no symptoms or in fast eating enough fluid or food may be held back momentarily to cause an overflow into the larynx and consequent choking or strangling. Large webs produce definite obstruction so that the patient is finally reduced to a liquid or a minced diet and goes to the table in terror or eats alone also in fear. In time such people become very thin from lack of sufficient nourishment.



FIG. 1. Tracing of an X-ray plat of an oesophageal pouch (M. S.) before operation. Note the large bolus of bismuth just above the pouch. Arrow points to pouch.

**Diagnosis** I feel that I shall be taken to task for advocating the ether examination of all patients with suspected webs of the oesophagus. Nevertheless this is my position. If the examination is made without local anaesthesia or for that matter with it and with the small tubes which this method of examination entails the chance of finding a web is small. In the early days of oesophagoscopy it happened a few times both to me and to some of my colleagues to examine cases of slight difficulty in swallowing without finding the cause of the trouble. Nevertheless the negative examination ether examination I am speaking of was followed by a disappearance of the patient's symptoms. I remember two cases in which the introduction of the tube was hard. It finally entered the oesophagus but its introduction was followed by a little bleeding. When the blood was wiped away a triangular slit was seen in the oesophageal mucous membrane. Such cases were in my opinion unrecognized webs in which the pressure of the end of the oesophagoscope had unbeknown to the examiner divulsed the web (Fig. 3).

**Treatment** Once the position and the nature of the web has been made out under ether with the aid of the ballooning oesophagoscope the treatment is very simple. The end of the oesophagoscope is pressed firmly against the outer edge or rim of the web and the inner or free edge centered at the opening

of the examining tube. When the web is thus made taut a scissor punch or a knife previously placed in the operating window plug is put in position and the free edge of the web is incised. This done the end of the oesophagoscope is pushed down hard against the partly divided web. Generally the pressure of the tube divulsed the rest of it. If it does not the web can be again cut. The cut and the slit seem to go through only the mucous membrane and scar tissue of the web. As yet I have had no infection following this method of dealing with webs.

**After treatment** For two days nourishment is supplied by enemata. On the second day sterile water is allowed by mouth and on the third day no reaction following the operation broths are given and the enemata stopped. For the first week the patient is given twenty grains of subnitrate of bismuth four times a day with the idea of coating the raw surfaces and thus perhaps minimizing the chances of infection (Jackson). On the seventh day as large a bougie as will easily pass is introduced. Such a bougie is passed twice a week for a month. After this time the patient's ability to swallow must be the guide to the intervals of using the bougie. Intelligent patients can be taught to pass the bougie on themselves. The bougie may have to be passed at intervals for years perhaps, as in strictures for the rest of the patient's life.

**Results** After cutting or divulsing a web there is generally no reaction. For the first few days the patient complains of a sore throat and indefinite discomfort sometimes amounting to actual pain behind the sternum. The temperature chart is almost flat. By the fourth day all discomfort has disappeared and the patient is taking semisolids without trouble and by the end of a week is eating normally. The joy of these patients at being restored to normal eating is pathetic. The satisfaction of the operator is not inconsiderable.

#### DIVERTICULUM OF THE OESOPHAGUS

In his latest book Jackson divides diverticula of the oesophagus into traction and pulsion diverticula. The traction variety is

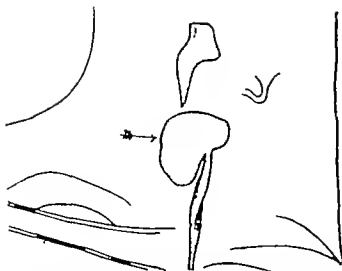


Fig. 11 Tracing of an X-ray plate of an oesophageal pouch (Mr S) ten months after slitting half of the common wall. Notice the widening of the upper third of the pouch. Anteroposterior plate. All difficulty in swallowing has disappeared and a No. 48 English bougie passes easily. Arrow points to pouch.

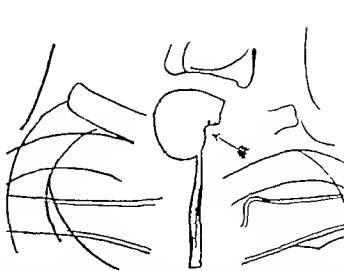


Fig. 12 Tracing of an X-ray plate of an oesophageal pouch (Mr S) ten months after slitting half of the common wall. Notice the widening of the upper third of the pouch. Anteroposterior plate. All difficulty in swallowing has disappeared, and a No. 48 English bougie passes easily. Arrow points to pouch.

situated usually within the thorax and is due to the adherence of cicatricial tissue the pulsion diverticulum is situated in the neck but may extend to the upper thoracic aperture (Fig 5)

*Traction diverticulum of the oesophagus*  
Traction diverticulum of the oesophagus is a rare condition rarely gives symptoms and is rarely discovered. A traction diverticulum is a one sided enlargement of the oesophagus. This may form a true pouch as the specimen shown in Fig 6 shows. Usually however this is not the case. Jackson quotes Keith on the etiology of traction diverticula as follows

First there is a localized adhesion of the oesophagus to the surrounding part usually due to inflammation of one of the bronchial glands.

Second traction of this adhesion occurs during coughing deep inspiration, and deglutition. In these acts the trachea and the oesophagus move independently and elongate the adhesion formed between them with the result that traction diverticula of the oesophagus are formed.

*Pulsion diverticulum of the oesophagus*  
Pulsion diverticula again quoting Jackson are usually small and may not have a capacity of more than 1 or 2 cubic centimeters. On the other hand, they may be large enough to bulge out the neck like a golfer. In the three last cases which I have had all were

centrally located. Two were about an inch long and extended half way to the clavicle. The third measured two inches long and reached the lower edge of the clavicles. Pulsion diverticula are seldom seen before middle age.

Pulsion diverticula are usually said to be due to a hernial protrusion of the oesophagus through the weak triangle of the posterior wall and are caused by the pressure of innumerable boluses of food. A cicatricial stricture at the beginning of the oesophagus might in some cases be the starting point of a pulsion diverticulum or pouch. In the last oesophageal case that I examined there was an annular stricture at the mouth of the oesophagus and behind this was an indication of a beginning pouch. Congenital pouches have been reported and Semon reports a congenitally deformed larynx which was accompanied by a pouch.

If I am not mistaken embryologists have described pouches at the beginning of the oesophagus. When you look into a pouch the whole pharynx seems to be lowered and the idea persists in my mind that some diverticula are due to the attempt to form a double oesophagus. At the present moment the hernia theory is the one that has the most adherents. Once a pouch is started every thing conspires to make it enlarge.

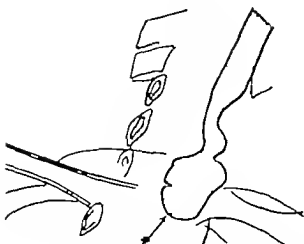


Fig. 3. Tracing of an X-ray plate of an oesophageal pouch (M. M.) before operation. A teroposterior plate. Notice the large bolus of food in the pouch and the constriction at the top of the pouch. Two-thirds of the common wall were cut and today five months after the operation, swallowing is still normal and no food is regurgitated. Arrow points to the pouch.

**Symptoms.** The symptoms of a pouch are gradually increasing difficulty in swallowing until in advanced cases the patient is reduced to a liquid and minced diet. Eating is accompanied by straining and this is followed by the return of some of the food just swallowed. If the pouch is a large one the patient has to leave the table periodically and by gagging and vomiting empties the contents of the pouch. Shortly after eating in some cases or in a few hours in others the patient brings up undigested food. There is a feeling of fullness in the region of the clavicle and a sound of gurgling as if air were imprisoned in the oesophagus. At times food is returned which has been in the pouch for some days. At night the pouch tends to empty itself and the irritation of this causes more or less coughing and straining. Pain is never in my experience complained of. As the pouch gets larger and the opening of the oesophagus smaller the patient swallows with more and more difficulty and eats more and more alone. The patients manage to get enough food to live but they are usually thin to scrawny. I have never seen a patient who was fat who suffered with a pouch. Meal time is one of loneliness, dread and disgust.

**Diagnosis.** If a patient with an oesophageal pouch is examined with the laryngeal mirror



Fig. 4. Oblique plate of same patient as in Fig. 3.

and the examiner presses on either side of the patient's larynx one or both of the pyriform sinuses will be seen to overflow with a frothy dirty fluid. The larynx appears normal as a rule but may be reddened. I pass over with the bare mention of them the old methods of making a diagnosis of oesophageal pouch by filling the pouch with shot and then taking an X-ray or by attempting to pass a bougie only to have it halt at the level of the clavicle and then on withdrawal and reinsertion passing after many attempts on the part of the surgeon and much gagging on the part of the patient into the oesophagus. In most cases it is impossible to pass a bougie however small. The three modern methods of determining the presence of a pouch are the fluoroscope, the X-ray plate after swallowing bismuth paste and the examination of the upper part of the oesophagus with the ballooning oesophagoscope. If the act of swallowing bismuth milk is watched with the fluoroscope the pouch will be seen to fill and to make a small rounded tumor above the clavicle. When the pouch becomes full a thin stream trickles from it into the oesophagus. This stream continues thin for about the length of the pouch and then the oesophagus swells out to its normal size. Is this narrow part of the oesophagus behind the pouch due to the pressure of the full pouch or is there an element of true stricture in the upper part of the oesophagus? The behaviour of the pouch under cutting rather favors the idea that there is an element of stricture in the narrowed oesophagus. The

fluoroscope shows the pouch to the trained eye the X ray plate shows it to the untrained. The anteroposterior plate gives a globular tumor in the median line the lower border of which is at or just above the inner end of the clavicles. It measures in the vertical diameter from an inch to two inches and in the transverse diameter about half an inch to two inches. The only certain way to make out a pouch is to see it by aid of the oesophagoscope and the best method and I say this with all the emphasis at my command is to examine under the relaxation of ether with a large oval oesophagoscope with a ballooning attachment. I feel at times when speaking of the ballooning attachment of the oesophagoscope like a voice crying in the wilderness but I shall continue to cry on.

*Examination with the ballooning oesophagoscope.* The patient is given a preliminary dose of atrophine and morphine. I have been a little uneasy about the use of morphine since Jackson has spoken so strongly against it as abolishing the protective cough reflex but still use it. Atrophine dries up the secretions of the trachea, bronchi and of the oesophagus. I have clung to the theory advanced by Crile years ago that atrophine blocks off the pharyngeal and vagus reflex. So far in oesophageal examinations of any and all kinds I have had no trouble from the morphia none from the vagus reflex and none from the examination under ether. I have been astonished many times that the oesophagus tolerates the large tube and that there is no interference with the larynx either reflexly or from pressure. Once the examination is started it is very seldom that the tube has to be withdrawn. The ideal method of giving the anæsthetic is by a catheter placed in the trachea.

The patient is placed on the table on his back with the head hanging over the end and the head held by the Boyce method except that no gag is used after the tube is inserted. A short, nine inch oval oesophagoscope is employed. This is carried down by sight to the bottom of the right pyriform fossa and behind the cricoid cartilage and then swung into the middle line. It always falls into the open mouth of the pouch. A bougie always

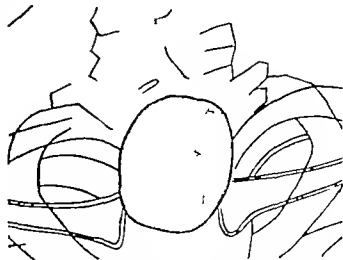


Fig 15. Oesophageal pouch. Mr. F. 71 years old. Tracing of an anteroposterior X ray plate. Very nearly all of the common wall was cut at operation.

does the same when passed without or with ether. The pouch is easy to find. The operator makes sure that he is in a pouch by ballooning it. He discovers that he is in a closed sac with no opening ahead. The tube readily passes to the bottom of this and halts. On removing the window plug and measuring the level of the bottom of the pouch by laying it off on the patient's neck it will be found that the usual pouch stops at the level of the clavicles or a short distance above. The pouch is cleaned either by swabbing or by washing it out through the tube with the foot of the table raised or best of all the contents are sucked out by an electrically driven suction apparatus. This apparatus is essential in all except the most casual oesophageal work. The walls of the pouch may not be unlike the walls of the oesophagus except for the fact that they are generally redder. The whole pouch lining is sometimes smooth. It is more common however to find the bottom of the pouch ribbed with small fibrous trabeculae. In many cases if the bottom of the pouch is grasped with forceps the sac can be turned wrong side out like a glove finger. While Jackson's book was in press and before I began to cut the common wall between the pouch and the oesophagus I tried to devise some operation which would obliterate a pouch by turning it wrong side out and either clamping or suturing it. This manipulation would be easy for Lynch

but hard for most of us. Cutting however is easier and for the moment I am confining my attention to this and shall continue to do so until I prove the end results of cutting. But to return to the examination. The examiner finds that he is in a pouch by ballooning. He determines the condition of the pouch and its size and then begins the hunt for the lost oesophageal opening. In my experience the opening of the oesophagus is always placed anteriorly and it is always round and small so small in fact that it will not show as an opening unless the point of the tube is turned well upward and air forced strongly into the tube by the foot bellows. It is in finding the opening of the oesophagus that the ballooning is most useful. By it and the pouch is found first and then the tube is slowly withdrawn and pressed firmly upward the assistant meanwhile strongly working the foot bellows. At the moment that the tube slips out of the mouth of the pouch the examiner sees to his joy in the median line at twelve by the clock a small dimple. He at once centers this in the opening of the tube and presses downward. As he does so the dimple becomes a hole and the oesophageal opening is found. He now puts the operating window in place with a probe or a small bougie in it, and all the time keeping the oesophagus open by air pressure passes the probe down the oesophagus. Sometimes continued pressure of the mouth of the tube reinforced by strong ballooning will soon allow the end of the oesophagoscope to enter the oesophagus. At other times a dilator has to be passed into the oesophagus and the mouth of the oesophagus stretched before the tube will be admitted. Once the tube has passed into the oesophagus the short tube is replaced by a full length tube and the whole length of the oesophagus explored for further pathology. In pouch cases it is not usual to find any other abnormality.

Jackson speaks of the oesophageal opening in pouch cases as the subdiverticular opening. The pouch is really a continuation of the pharynx downward but as you examine these cases under ether and with the ballooning oesophagoscope the pouch has a distinct orifice which looks like the normal oesophagus

as it opens ahead of the tube. It is only when the tube is found to halt in a blind sac that it is seen that there is a pouch present. When the tube is withdrawn the distinct mouth of the pouch appears again and at the level of this the opening of the oesophagus is found.

*Treatment.* There have been two methods of treating oesophageal pouches. First, to find the oesophageal opening and dilate it and then keep the dilatation by the passing of bougies, at first by the physician and then for an indeterminate time by the patient himself. Second to dissect out the sac by external operation. I became interested in oesophageal pouches through the use of the oesophagoscope. I found that the simple procedure of ballooning easily revealed the oesophageal opening and that it was easy to dilate the mouth of the oesophagus. Up to a few years ago the cases which fell into my hand were managed in this way. All the cases except one were able after the dilatation of the mouth of the oesophagus to pass the bougie for themselves and all have disappeared from observation except one. There will be more about this one later. How many of these bougie cases have finally become tired of the constant passing of the bougie and have had their pouches dissected out I do not know. The one case of dilatation (Pouch Cases, Case No 4) which has remained under observation was improved by the stretching of the mouth of the oesophagus for a few months but finally shut down so that no manipulation with which I was familiar enabled me to pass any type of bougie, staff or probe into the mouth of the oesophagus. This case has just had the common wall cut. The method of dissecting out the oesophageal pouch is a thoroughly scientific procedure perhaps the most scientific of all. It gives good results in most cases. Pouches do, however return after dissection and old statistics give the mortality of the operation as 10 per cent.

Many cases I understand are done in this way at the Mayo clinic. I have no quarrel with it. All who try the dissecting method should take advantage of an improvement in technique brought about by the use of the

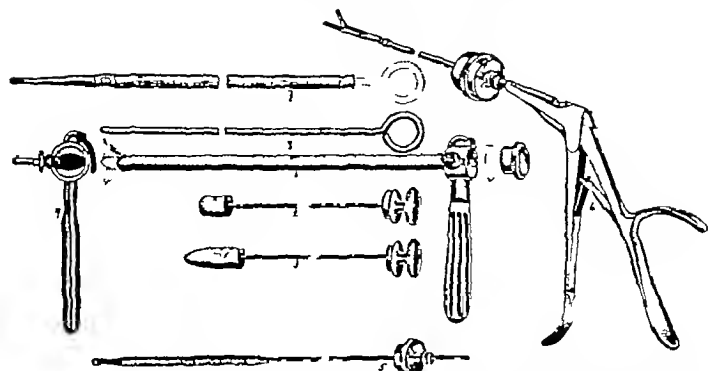


Fig. 16. 1 2 3 4, Oesophagoscope with ballooning attachment. 1 2 and 3 Oesophagoscope, the window plug and two obturators. The obturators are seldom used as the tube is practically always passed by sight. 4, An end view of the oesophagoscope. The window plug is not in place. The accessory tube for ballooning leaves the main tube at the top. From this, rubber tubing leads to a foot bellows. 5 The operating window plug. The cuts show the operating window plug through which a staff tipped with a bougie has been passed. This plug permits the use of any instrument which has the proper shaft. The operator has the advantage of constant ballooning while he is working. 6 7 and 8 Oesophageal instruments. 6 Shows the adissor pouch in place in the operating window plug and ready to adjust in the oesophagoscope. 7 and 8 show a deflation bougie for letting air out of the stomach should the stomach become overinflated during ballooning of the oesophagus. A stylet (8) stiffens the bougie so that it can be inserted quickly. So far I have never had to use this bougie. Generally on removing the window plug the air returns with a rush from the stomach through the oesophagoscope. During the ballooning one assistant watches the stomach and warns the operator when it is markedly distended. So far the pressure of the distended stomach has not interfered with the action of the heart.

oesophagoscope (Jackson Gaub) This consists in one operator finding the pouch with the oesophagoscope and by pressure outward with the end of the tube outlining the pouch for the operator as he dissects down upon it from the outside. Two such cases are reported in Jackson's latest edition of his book! Of our Boston surgeons Dr Mixer has had the largest experience with the treatment of pouches. His view is that small pouches in young people should be dissected out whereas pouches in old people or pouches which are large enough to invade the thorax should be managed, if possible with the bougie.

Six or seven years ago I began to wonder what would happen if the surgeon should cut the common wall between the pouch and the oesophagus. I told Dr Mixer that

I hoped to cut this wall some day and he replied that he had thought of the same thing. As he did not use the oesophagoscope he did not have the means of cutting it. Working with the oesophagoscope aided by ballooning I found that I had. What deterred me was the fact that I did not know what vessels or nerves ran in the common wall. In normal anatomy there should be no nerves or vessels of importance there. Still there might be vessels of sufficient size to give trouble. The possible infection of the posterior mediastinum seemed the greatest danger. Mediastinitis is more deadly than either peritonitis or meningitis. In the dissecting room I have hunted in vain for specimens of oesophageal pouch so that I could orient myself from them. In the Harvard Medical School Museum there is but one specimen of this kind (Fig 5). By studying the pouch cases that came



under observation by ballooning them and turning them inside out I became convinced that there was nothing of surgical importance in the common wall so three years ago I nicked it and then this past year cut the wall half through in one pouch case two-thirds through in another and in my third and last case practically all of it was cut. The mediastinum did not show the slightest tendency to infection in any of the cases. The details of these cases I shall come to in due order. In all of these cases there was complete relief of the clinical symptoms.

#### THE TECHNIQUE OF CUTTING THE COMMON WALL

The first step toward cutting the common wall is to locate the opening of the pouch and the opening of the œsophagus doing so under ether with the ballooning œsophagoscope. Then with the operating window plug through which the scissor punch is passed the common wall is brought out so that it bisects the transverse diameter of the œsophagoscope and then the first cut is made in the center of it. The incision which the punch makes is about a quarter of an inch long (Fig. 8). There is but slight bleeding. The forceps and operating plug are then removed and a clear field is obtained by suction. After replacing the forceps and the plug and balloon again the œsophagoscope is pushed a little further down and a second cut is made. These manipulations are repeated until the common wall is slit to within an eighth of an inch of the bottom. This small rim is left at the bottom of the pouch to wall off the mediastinum or rather to avoid opening it. If the œsophagus and the pouch do not lie close together or rather if they are not actually glued by old inflammatory adhesions the mediastinum will have been opened by this first cut. Probably every pouch is walled off by adhesions posteriorly. Theoretically at least the patient and the operator have to take the risk of opening the posterior mediastinum. All that I can say is that so far no infection has followed the cutting in four cases. After the first cut the œsophagoscope slips into the œsophagus readily and of course continues to do so. As the cutting proceeds the cavity

of the pouch becomes smaller and smaller until nothing is left but a small crescentic rim to show where the common wall was (Fig. 9).

*The postoperative care.* The patient is starved for twenty-four hours before operation and given four doses of subnitrate of bismuth of twenty grains each during this day (Jackson). During the operative manipulations the patient is kept with his heels higher than his head. He is put to bed in this position and kept this way for a few hours. He is fed by rectum for two days. During the first day he has nothing by mouth except the four doses of bismuth. On the second day he is allowed sterile water and on the third day broths without milk. Old patients are given a bed rest on the second day and are allowed to get out of bed on the third. At the end of a week the physician passes a No. 48 English bougie every second or third day and then the patient is taught to pass the bougie for himself at first once a day for a month then twice a week for a month and finally once a week for another month. How long the bougie will have to be passed by the patient I do not know. I have the feeling that its use can be dispensed with after six weeks. This point will have to be settled in the future. Should it prove necessary to pass the bougie indefinitely this will of course be a drawback to the operation. When this point is settled I will report on it.

What happens to the pouch after cutting the common wall? Does the pouch shrink? I have had the opportunity to X-ray but one of the three cases after operation. What I want of course is an ether examination on these operated cases but even a cocaine examination would not appeal to my first case a banker of a Massachusetts city. All that I can say is that the clinical symptoms have disappeared in all the cases and from not being able to pass any bougie at all before the operation each patient now passes on himself a No. 48 English. The opportunity will come sometime to pass a tube on such operated cases. One case however was X-rayed ten months after the operation and some inferences can be drawn from the plates taken before and after operation. The second plate shows that the pouch has grown a little

larger at the top and that the stream of his muth leaving it is about twice as large I had made up my mind that the pouch would shrink and was much disappointed on seeing the plate but on thinking it over I found that the clinical result could be explained without the pouch shrinking All that had been done to the pouch was to slit the common wall its other walls were not touched Therefore the pouch did not shrink. However the slit must have remained open otherwise the symptoms would have returned and the passage of the large bougie would be impossible. When the patient swallows the pouch fills with bismuth. This coats its sides and gives a shadow the same as before operation but the pouch which had been operated on immediately empties itself into the oesophagus. This is as far as I can go with my present knowledge The cutting simply lowers the pharynx but does not change the side walls of pouch

#### CLINICAL CASES

I have already given the symptoms of webs and pouches of the oesophagus and shall make these histories mere skeletons I have had seven webs and perhaps ten pouches Not a large number I am sorry to say The patients are now scattered and I quote largely from memory The salient points however are still fresh in my mind

#### WEBS OF THE OESOPHAGUS

**CASE 1** The patient was a woman about 45 years of age and was a housekeeper for a Harvard professor For five years she could not eat through a meal without leaving the table once or twice to spit up food which had accumulated in her throat She was reduced to a liquid diet and was New England thin. Examination showed a membranous web extending the whole circumference of the upper part of the oesophagus with a small central opening The web was disposed of by placing an oesophageal dilator through the perforation spreading the dilator and withdrawing it open, thus dilating the web The woman at once regained normal swallowing (Fig 3 2)

**CASE 2** This patient was a woman of the same type but a little younger 30 years of age. Six years ago she had typhoid fever and after this developed difficulty in swallowing which increased until for the two years before the examination she could eat only liquids. To my surprise examination with the fluoroscope gave only a slight delay in swallowing at the lower end of the oesophagus. The

X ray plates showed nothing further (Fig 4) On examination with the oesophagoscope however a large web extending from right to left was found at the upper end of the oesophagus behind the cricoid cartilage. This was cut and the tube forced through it only to find a smaller web a short distance below the first one. The second web was on the left. This was split by forcing the tube end by it Below the second stricture and at the level of the bottom of the cricoid cartilage there was a third and smaller crescentic web springing from the right side of the oesophagus. This like the second was slit with the pressure of the end of the tube The patient regained normal swallowing at the end of four days The three partial webs in this case were much like the successive crescentic strictures which are found in some corrosive strictures of the oesophagus in children The important point in the case is the fact that the fluoroscope and the X ray showed no abnormality in swallowing The stricture was so high that the fluoroscope did not detect it. With this point in mind sharper observation in the future may detect some abnormality in similar cases. Once by the web the food passes normally The clinical symptoms in such cases are of more value and are more reliable than either the fluoroscope or the X ray plate.

**CASE 3** This patient was a pitifully thin anemic toothless woman of 54 and a cook. She gave a history of diphtheria when she was 10 years old For seven years she had had difficulty in swallowing and was living to use her own language and she ought to know on slops. If she took anything acid she strangled terribly again her own words (Fig 3) Examination showed in the upper part of each pyriform fossa and just below the arytenoid cartilage a small triangular web These webs probably caught the acid fluid and spilled it into the arytenoid commisure. At the lower level of the cricoid cartilage there was an annular scar tissue stricture with a central perforation about a quarter of an inch in either diameter The stricture was dealt with first. It was dilated with the oesophageal dilator without making much progress Then the tube end was pressed firmly against the margins of the stricture until finally the right edge gave way in a linear tear The tube was forced on and the lower part of the stricture passed in on either side of the tube as a crescentic fold. These folds were cut with the scissor punch and the tube then passed into the oesophagus beyond. The short tube was replaced by a full length tube which passed easily into the stomach. Each of the webs below the arytenoid was then cut using the short tube In this case the fluoroscope showed no abnormality of the upper end of the oesophagus although I warned the operator to look for it. The fluoroscope showed only little delay at the lower end of the oesophagus There was probably a slight stricture at this point but the tube easily dilated and passed it This case is of further interest as showing the presence of asymmetrical webs and because of the probable

etiology of the webs namely diphtheritic ulcerations. Such small webs are I imagine present in many cases of so-called gluttonous hysteria due as I said before to some form of trauma or some ulcerative process.

#### POUCHES OF THE ESOPHAGUS

**CASE 1.** This patient is a patent lawyer about 45 years old. He gave the type all symptoms of a pouch. I saw him three years ago. The X-ray showed a pouch. The examination was carried out in the usual manner. The opening of the esophagus was dilated and in addition a small cut was made in the common wall. The symptoms were at once relieved. He was taught to pass the bougie on himself and being mechanical he made a habit of one with a bulbous end which he used at regular intervals for twelve months. At the end of this time he was told to stop using it on his symptoms having returned. This was my first attempt at cutting the common wall and I was naturally a bit anxious for the first few days of his convalescence. No unpleasant symptoms resulted.

**CASE 2.** During the past year I have extensively cut the common wall between the esophagus and the diverticulum in three cases. The first of these was a banker sixty years old. The X-ray and the esophageal examination showed a pouch of moderate size (Fig. 10). The symptoms were of moderate severity and were of a very resistant nature. The physician who referred the case could not pass a bougie of any size. One half of the common wall was cut. Swallowing at once became normal and has remained so for the ten months which have elapsed since the operation. He still passes on himself a No. 45 French bougie twice a week. Once or twice a month if he happens to cough he brings up a flake of food. Beyond this he has no symptoms. A week ago for the purposes of this paper he was X-rayed again. The lower part of the pouch is the same in size as before but the upper portion is a little wider. How long the patient will have to pass his bougie I do not know. Whether the pouch will shrink in time whether it will enlarge or remain the same and, as now continues to give no symptoms I must wait to learn. Should symptoms return it should be an easy matter to cut the common wall still more or to recut it if it eventually gives together (Fig. 11).

**CASE 3.** The patient who ranks as the third case of cutting is a Canadian farmer and ornithologist. He came to me through a fellow ornithologist of Boston. His symptoms were of moderate severity and had existed for two years. He had a good sized pouch (Fig. 13). Two-thirds of the common wall were cut. This was five months ago. I heard from him a month back and he was free from all symptoms. At that time four months, after the operation he was told to discontinue the use of the bougie. A week after the operation an attempt was made to take an X-ray but the blismuth

went down so rapidly that the plates showed nothing (Fig. 14).

**CASE 4.** The patient who furnished the fourth and last case is a retired English army officer 71 years old. He is a graduate of Oxford, lived well in the days gone by is a judge of pictures and dogs, and secretary of the Massachusetts Automobile Association. He knew many people and is chairman of the round table at the Boston Art Club. I mention these personal items to show that everything seemed to be staged for a calamity. Naturally I pointed upon him with some foreboding. If first met him three years ago. This was before I had cut the common wall in any case. The examination showed a large pouch (Fig. 15). The opening of the esophagus at that time was dilated. If a few months he swallowed a little better and at first it was possible to pass a good sized bougie. Finally however it became impossible to enter the throat to find the mouth of the esophagus. I had no kind of an instrument that is with us there. The only last good that I managed to learn was from the fact that I discovered that he was at better lying on his stomach for the past two years therefore he has taken his food. He had to be either liquid or minced, lying on his belly. Six months ago a final attempt was made to pass an instrument into the esophagus. The attempt failed.

I thus cut almost the whole of the common wall was cut nearly about a eighth of an inch was left on the right wall off the mediastinum. It proved to be the largest pouch that I have had as it reached a little below the lower border of the inner end of the lard. If it had not been for the operating window plug which was used for the first time in this case I do not know whether I could have dealt successfully with so much of the common wall. He used after the first lard had been cut the esophageal wall and the wall of the pouch separated. The lower portion of the pouch was disconnected. The right wall folded together and I could not tell where to make the next incision. The operating window plug however extended both parts of the common wall and kept them in full view until the bottom of the pouch was reached. The operating window plug proved to be a great advantage over the former plug which allowed only intermittent ballooning. The bottom of the pouch in this case was ribbed with white scar tissue so that the pouch could not be inverted as in the other cases.

On the third day Mr. F. had his first bowl of soup. The day before he was given sterile water which he allowed normally. This soup therefore was his first real meal and I sat by and watched him eat it. He began eating with a spoon and had no trouble. I could stand it no longer and told him to drink it down. He took the bowl in both hands and drank greedily until he had emptied it. For the first time in six years he ate upright like a man. His joy was unbounded. The next day he had a chop for lunch and beefsteak and vegetables for dinner.

## SUMMARY

Webs of the oesophagus may follow trauma or any disease which causes ulceration. The web may be an insignificant fold attended by indifferent or slight symptoms or it may be large enough to give severe obstruction in swallowing. Webs of the oesophagus occur behind the cricoid cartilage and neither the fluoroscope nor the X ray plate shows their presence.

Webs are best treated by cutting, aided if necessary by division with the end of the oesophagoscope.

Three cases of cutting the common wall of an oesophageal pouch have shown that—

1 The procedure is easily accomplished.

2 It is probably safe.

3 It results in a clinical cure.

The actual fate of the pouch after cutting

is not yet established. A sufficient slit to maintain normal swallowing is readily kept open by the passing of bougies. It is still to be settled how long the patient must pass the bougie.

The best method of diagnosing webs and pouches is under general anaesthesia and by the aid of a large oval ballooning oesophagoscope.

Cutting the common wall in a large oesophageal pouch is only practical under the constant ballooning made possible by the operating window plug.

If it should prove that the slit in the common wall made by the knife or the scissor punch should in time reunite it would be worth while to try dividing the common wall with the cautery. Should the common wall reunite it is a simple matter to again divide it.

## SURGICAL TREATMENT OF BANTI'S DISEASE

REPORT OF THREE CASES<sup>1</sup>

BY CHARLES D. LOCKWOOD, M.D., JACOB WEN, CALIFORNIA

**S**URGERY of the spleen has received a great impetus in the past five years and a sufficient number of splenectomies have now been performed to establish a fairly secure basis for determining the indications and value of the procedure. My contribution is based upon a careful review of the literature and personal observation in three cases of Banti's disease splenectomized and herewith reported.

Dr. G. B. Johnstone in an exhaustive résumé of this subject in 1908 reviewed all cases of splenic anemia 61 in all treated by splenectomy up to that time. Of that number 49 recovered and 12 died a mortality of 19.5 per cent. I have endeavored to collect all cases reported since 1908 and I add three cases of my own all of which recovered. Observation of my own cases and a study of those reported in the literature of the past few years leads me to believe that the term "splenic anemia" best designates the various phenomena accompanying this disease and as suggested by Rodman and Willard three stages may be recognized.

The first stage, often extending over a long period of years, is characterized by splenomegaly, anemia, gastro-intestinal hemorrhages and pigmentation of the skin. The second stage, of short duration, gives only the added symptoms of renal insufficiency. In the third or terminal stage the dominant feature of the disease is the failure of liver function with marked ascites and extreme emaciation. The symptom-complex described by Banti applies especially to the ascitic stage of the disease. Two of my cases fall in the third stage of the disease, one belongs in the second stage. All three cases showed greatly enlarged spleens, anemia of the secondary type, leucopenia and pigmentation of the skin. There was no etiological factor common to all three cases. All denied syphilis although one case gave a positive blood Wassermann.

## OPERATIVE TECHNIQUE

A long left rectus incision was found entirely satisfactory for the removal of the three spleens although two of them were very large and many adhesions were encountered. After the adhesions were separated, the spleen was quickly delivered from the abdomen by enucleating it with the forearm and elbow much as one would pick up a large watermelon with one arm. Much time may be lost by futile attempts to deliver a large spleen by grasping the edge with the fingers or instruments. Attention has been called by Dr. W. J. Mayo to the importance of ligating the splenic artery before constricting the veins. Much blood is thereby saved the patient. In my second case a huge spleen the vessels were clamped simultaneously and the spleen removed before ligation was attempted. The organ was very vascular and contained a large amount of blood. Fortunately it was thrown into a large sterile basin. When the clamp was removed from the vessels attached to the spleen about a litre of blood escaped into the basin. Dr. Harlan Shoemaker who was watching the operation suggested that the blood lost from the spleen be reintroduced into the patient's veins. I promptly acceded and within ten minutes 750 centimeters of the patient's own blood was filtered, citrated and reintroduced into his veins. This procedure of autotransfusion was thought to be original, but I have found that Lichtenstein reported eight cases of ruptured extra uterine pregnancy and one of rupture of the uterus, in which blood was scooped out of the abdomen, defibrinated diluted with salt solution, and reintroduced into the patient with brilliant results. In both my cases autotransfusion proved of striking value.

**CASE 1.** M. R. male age 7 Caucasian occupation brakeman. Chief complaint weakness, anorexia, dull heavy sensation in abdomen, bleeding from the bowels, vertigo at times. In September

ber 1912 when apparently in perfect health the patient said his bowels filled with blood and he passed a large amount of black, tarry foul-smelling material from his bowels. This was accompanied by deep heavy pain in the lower abdomen. From this time until December 1915 he was able to do only light work. He tired easily and had constant heavy feeling in his lower abdomen. One week before entering the hospital he had another severe hemorrhage from the bowels, accompanied by sharp pain in the abdomen. He also spat some blood at this time. Family history negative no serious illness denied venereal disease. Habits drinks an occasional glass of beer smokes tobacco. Physical examination thin anemic young man. Head negative except for pyorrhea and decayed teeth. Chest negative except for pulsation of the vessels of the neck. Abdomen liver slightly enlarged symmetrical abdominal distention. Fluid in the peritoneal cavity. Splenic tumor extending two fingers breadth below the umbilicus. Genitalia and extremities negative. Reflexes normal. Wassermann positive.

Blood examination, December 14 1915 hæmoglobin 43 per cent (Tallquist) color index 8. Erythrocytes cmm. 2,480,000 leucocytes cmm. 6,800. Hæmoglobin 25 per cent (von Fleischl) color index, 6. Erythrocytes cmm. 2,100,000 leucocytes, cmm. 11,800. Polymorphonuclears 80 per cent lymphocytes 14 per cent large mononuclears 4 per cent eosinophils, 2 per cent size variable macrocytes positive microcytes positive.

Operation January 4 1916 Splenectomy and omentopexy were performed through the left rectus incision. The abdomen contained a large amount of straw-colored fluid. During the closure of the incision one quart of normal salt solution was given under the breast.

Postoperative history Prompt recovery from operation, with temporary improvement in general condition and then gradual failure. There was no return of hemorrhage. January 10 1916 six days after the operation the blood picture was as follows:

Erythrocytes per cmm., 3,100,000 leucocytes per cmm. 27,200 differential count stain Wright method air polymorphonuclears 41 per cent lymphocytes 24 per cent, large mononuclears 33 per cent poikilocytosis absent size 5-14 macrocytes positive few. Remarks coagulability increased color red cells pale.

January 16 1916 twelve days after operation.

Hæmoglobin 60 per cent estimated color index 1.2 erythrocytes per cmm. 3,150,000 leucocytes per cmm. 24,000 differential count polymorphonuclears 64 per cent lymphocytes 5 per cent large mononuclears 18 per cent eosinophiles 4 per cent poikilocytosis none macrocytes positive.

January 24 1916 three weeks after operation leucocytes per cmm. 13,400

When patient was last seen in October 1916 he was extremely emaciated and had marked ascites.

He was being tapped twice weekly and as much as three or four gallons of fluid withdrawn.

Laboratory record The spleen measured 5 by 15 by 24 centimeters. Microscopic examination increased connective-tissue stroma, many young leucocytes in the vessel spaces.

Pathologic diagnosis hypertrophied and engorged spleen

CASE 2 John S. age 31. Principal complaint was weakness periodic headache alternating diarrhoea dyspnoea epistaxis and occasional jaundice. Previous diseases malaria, at 13 years of age measles and chicken pox gonorrhoea denies syphilis. Habits steady. Moderate drinker smokes and chews tobacco. Has no drug habit. Physical examination well nourished subicteric tinge to the skin mucous membranes pale. Abdomen distended epigastric tenderness the liver extended two fingers below the costal margin. Splenic tumor reached almost to the brim of the pelvis. Examination otherwise negative. Wassermann on the blood negative.

Blood picture before the operation erythrocytes per cmm 3,100,000 leucocytes per cmm. 6,400 hæmoglobin 80 per cent differential count 200 cells small mononuclear 30 per cent large mononuclear 9 per cent indented nucleus 34 per cent, polymorphonuclear (neutrophils) 5 per cent polymorphonuclear (eosinophils) 34 per cent urine normal.

Operation April 16 1916 Splenectomy and omentopexy. Intravenous infusion of 750 cubic centimeters of citrated blood recovered from the spleen. Pathologic examination of the spleen gross examination of the spleen about five times normal size. Smears taken. Microscopic examination Smears show many small mononuclear leucocytes and a few polymorphonuclear cells also eosinophiles. Sections the capsule is thickened malpighian corpuscles are on an average a little larger than normal, the trabeculae are normal and the spleen pulp is replaced in many areas by connective tissue. Dimensions 8 by 14 by 22 centimeters weight 2 pounds 11½ ounces.

Postoperative history The patient made an excellent operative recovery but complained of much abdominal distress and for a time grew weaker. He then gradually improved and left the hospital much stronger. He has continued to improve with slight remissions. He is now able to do light work.

Blood picture June 12 1916 hæmoglobin 65 per cent color index 1 erythrocytes per cmm. 3,030,000 leucocytes per cmm. 16,800 polymorphonuclears 66 per cent lymphocytes 20 per cent large mononuclears 11 per cent eosinophiles 3 per cent poikilocytosis not marked nucleation none size, some irregularity polychromatophilia present.

Both of these cases are I believe, true cases of splenic anaemia in the third stage of the disease with the symptom-complex of Banti.

**CASE 3.** M S male age 47 Russian, occupation motorman. Admitted December 30, 1915. Complaint pain in the abdomen headache loss of appetite pain in the back and legs. Six months before entering the hospital he began to feel drowsy had headache poor appetite pain in the legs and numbness. In about three months he gave up work because of weakness. He began to have chills with high temperature up to 105 and light sweats. Patient became jaundiced. October 8 he went to the Crocker Street Hospital. He was given mercurialunction and potassium iodide in large doses, and improved his temperature returning to normal. The trouble recurred in about a month. He was again treated with mercury and potassium iodide and recovered sufficiently to go to work. The next time he did not improve by the treatment with mercury.

**Previous illnesses.** Measles. Diphtheria. Cerebral diseases. Family history negative. Habits alcohol moderately. Physical examination slight jaundice heart sounds faint systolic murmur over the apex and tricuspid regurgitation extends two fingers breadth below the costal arch. Spleen greatly enlarged. Abdomen seems distended and tympanitic. Stomach examination test meal negative. Feces negative no blood. Wassermann negative.

**January 11, 1916 exploratory operation.** Cultures made from the blood aspirated from the liver and spleen showed no growth. The surface of the liver was smooth.

Urine albumin a trace a few granular casts.

**Blood examination** February 24, 1916 erythrocytes per cmm 1,360,000 leucocytes per cmm 9,200 polymorphonuclears 40 per cent small mononuclears 46 per cent mononuclears 11 per cent.

**Blood examination** September 5, 1916 hemoglobin 50 per cent color index .85 per cent erythrocytes per cmm 2,940,000 leucocytes per cmm 22,100 polymorphonuclears 30 per cent large mononuclears 2 per cent small mononuclears 50 per cent size irregular polikilocytosis well marked macrocytes present.

**October 5, 1916 splenectomy.** Fifteen hundred centimeters of blood expressed from the spleen after removal was citrated and reintroduced into the patient's veins. He stood the operation well.

**Postoperative history.** Patient healed primarily but ran a high temperature for several days after the operation. He then began to improve temperature returning to normal and he remained better for a week or two when he had a relapse with high temperature loss of appetite and weakness. These relapses have occurred periodically up to the present time. Following attacks of fever the patient will have diarrhea for a day or two and temperature returns to normal.

**Blood examination** October 24, 1916 hemoglobin 60 per cent leucocytes per cmm 33,000.

**Blood examination** November 10, 1916 hemoglobin 60 per cent erythrocytes per cmm 3,160,000

leucocytes per cmm 33,700 polymorphonuclears 14 per cent large mononuclears 42 per cent small mononuclears 15 per cent eosinophils 1 per cent.

This case was variously diagnosed as *Hæmochromatosis*, chronic leukæmia, splenic anemia, and pyroplasmosis. The presence of a large spleen, a secondary anemia with slight jaundice and a leucopenia except during a period of fever justify the diagnosis of splenic anemia. Recent urinalysis and fundus albidus tests show very poor elimination and marked albuminuria. Phthalein failed to appear in the urine of the left ureter at the end of 30 minutes. It appeared in the esterified specimen of the right kidney in ten minutes. Total output in two hours was only 755 per cent. This failure of kidney function at times approaches complete pyrexia accompanied by high fever and rigors. It is characteristic of the second stage of splenic anemia.

**Blood count** November 23, 1916 erythrocytes 3,430,000 leucocytes 4,300.

I have collected 38 cases from the literature, and three cases of my own make 41 in all. Of this number six died as a result of operation making an operative mortality of 14.5 per cent. The operative mortality prior to 1908 in 61 cases was 19.5 per cent. No doubt there have been many cases which have not been reported and there are many more in foreign journals which I have been unable to secure but the cases herewith reported are representative of the surgical results in this disease.

Operation done in the first stage of the disease is curative in a large percentage of cases and the operative mortality is no higher than in other major abdominal operations. In the second and third stages of the disease there is still a large percentage of recoveries with great improvement of health. Our views regarding splenic anemia will no doubt change from time to time as our knowledge regarding the normal physiology and pathologic changes in the spleen become more exact. Our experience thus far in splenectomy for Banti's disease would seem to justify the conclusion that overfunctioning of the spleen whether of toxic or bacterial origin is the cause of the anemia and liver changes so characteristic of the disease. The most striking lesson taught by my cases was the great distensibility of the spleen and the importance of saving to the patient, either by preliminary ligation or by autotransfusion

the large amount of blood contained in the organ

### CASES REPORTED IN LITERATURE SINCE 1908

1. AMBROSE THEO Austral. M. Gaz. Feb. 22 1913. Male age 26. No tuberculosis, syphilis or malaria. Large abdominal tumor on left side. Liver two fingers below costal arch, secondary anemia. Splenectomy tail of pancreas tied off in operation. Postoperative symptoms of intestinal obstruction, temperature 104 daily for several weeks ascribed to injury of the spleen. Good recovery blood picture returned to normal.
2. BLAKE, J. B. Ann. Surg. Phila. Sept., 1915. Child 2½ years old. Family history negative. Child weak and pale. Painful micturition and defecation, large spleen filling half of the abdomen. Blood hemoglobin 45 per cent, white blood corpuscles 6,600 red blood corpuscles 2,496,000. Splenectomy complete recovery.
3. CLARK, E. D. (5) Female age 25 primary splenic anemia. Splenectomy March 1912. Large amount of blood lost in the spleen at the time of operation enough to blanch the skin. 1,000 centimeters normal salt solution intravenously recovery. Great improvement, patient alive in 1916.
4. FOWLER, R. S. Am. J. Surg. 1914 July 2 cases. CASE 1. Child male age 3½. Abdominal cramps, fever nose bleed enlarged spleen and liver moderate anemia. Wassermann negative. Splenectomy complete recovery.
- CASE 2. N. Y. St. M. J. Sept. 1914. Child female. Fourteen months old. Moderate anemia spleen enlarged six times natural size. Splenectomy complete recovery.
5. GROVES E. H. Bristol M. J. 1913 vol. No. 2. Advanced case with cirrhosis and ascites. Recovery after splenectomy.
6. GIFFIN Ann. Surg. Phila. Dec. 1915 Female age 2½ years. Splenectomy by Balfour recovery improvement.
7. HAKE, DOROTHY C. Female age 45 no hemorrhages recovery.
8. HETZROT Ann. Surg., Phila., Sept. 1914. Male age 30 years. Malaria at 14 jaundice for three months, splenectomy recovery.
9. HERRICK F. C. Ann. Surg. Phila. M. v. 913. Female Polish aged 33. Married. No chronic diseases. Weakness, jaundice, slight anemia, pigmentation of the skin. Splenectomy in July 1913. Recovery.
10. HUTCHINSON J. Excision of spleen for splenic anemia. Proc. Royal Soc. Med. vi. No. 8, Surg. Sec. p. 236. Boy seven years of age large spleen, emaciated, anemic. Splenectomy cured.
11. HARRIS W. L. Providence M. J. January 1908. Female age 34. Tuberculosis of the lungs with hemorrhages. Splenectomy. Recovery great improvement.
12. KIDD FRANK Proc. Royal Soc. Surg. Sec. viii. No. 8 p. 235. Girl seventeen years of age. Ascites hematemia. Splenectomy complete recovery.
13. LACOUTURE (4) Female age 39. Died 27 days after the operation.
14. LIBANER, H. H. Cal. St. M. J. Sept. 1915. Male age 25. No tuberculosis malaria but no other chronic disease. Spleen enlarged since childhood. Principal symptoms jaundice ascites, itching of the skin. Spleen reached to the level of the umbilicus. Patient tapped

twice before operation. Blood picture hemoglobin 30 per cent. white blood corpuscles 12,000 red blood corpuscles 3,000,000. Operation February 12 1914 by Dr. Edelman. After operation ascites disappeared blood returned to almost normal. Patient able to work.

15. MACDONALD (6) Chinese boy age 16. Splenectomy recovery.
16. MEYER, WILLY Ann. Surg. Phila. xlix 258. Operated March 23 1908. Recovery improved.
17. MAYO CLINIC. Twelve cases compiled by H. Z. Giffin, Mayo papers 1912. Two deaths.
18. POOLIE, E. H. Ann. Surg. Phila. Dec. 1914. Female, age 39. Bloody vomitus dark stools, enlarged spleen. Blood hemoglobin 28 per cent red blood corpuscles 1,600,000. Pre-operative transfusion with hemolysis and vomiting of blood. Second transfusion 700 centimeters of blood. Splenectomy recovery.
19. PRINCE, E. M. Alabama M. J., April 1910. Male age 26. Protracted attacks of malaria, large abdominal tumor. Splenectomy stomy convalescence perfect recovery. Health normal eight months after operation.
20. RAMEY R. L. Tex. St. J. Sept. 1914. Male age 31. Porter. No specific disease. Symptoms dismenia enlarged abdomen moderate anemia, no leukocytosis, ascites. Died nine days after operation. Developed some ascites after operation. Postmortem atrophic cirrhosis of the liver.
21. RODMAN and WILLARD (2) Report two cases. CASE 1. Young male operated upon by Dr. Guthrie, splenic anemia in second stage three years duration. Splenectomy patient died of gradual oozing from stomach and intestine.
- CASE 2. Female, age 18 splenic anemia. First stage. Splenectomy. Recovery with pleural effusion and pus in the lower abdomen.
22. SCHUPFER F. Gaz. deg. esp. Jan. 19 1908. Male age 4. Splenectomy hypercythemia after operation. Recovery.
23. SCUDDER (7) Male age 18 Russian. No previous infections. Chief symptoms bleeding from nose and mouth. Splenectomy Postoperative thrombosis of mesenteric vein. Gangrene of the small intestine. Resection death.
24. SOUTHERS, J. E. (3) Thrombosis of splenic vein. Severe shock postoperative. Large collection of pus in lower abdomen, fecal fistula, final recovery.
25. STUBBINS M. G. Boston M. & S. J. May 24 1914. Male age 8. Hematemesis, some chronic infection moderate anemia. Splenectomy. The patient had previously had an operation for infected gunshot wound. Splenic enlargement followed one year after Fair recovery.

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2. RODMAN and WILLARD. Splenic anemia with special reference to etiology and surgical treatment. Ann. Surg. Phila., 93 Nov.
3. SOMMER, J. E. Thrombosis of the spleen. Ann. Surg., Phila. 1908 June.
4. LACOUTURE. J. de méd. de Bordeaux, 1913, Dec. 14.
5. CLARK, E. D. Am. J. Obst., N. Y. 1916 Feb.
6. MACDONALD G. C. Pacific M. J., 1909 Nov.
7. SCUDDER. Ann. Surg. Phila. 1915 Nov.



## GANGRENOUS CHOLECYSTITIS

WITH REPORT OF A CASE DUE TO THE GAS BACILLUS

BY GILBERT GEOFFREY COTTAM, M.D., F.A.C.S., SIOUX FALLS, SOUTH DAKOTA

MRS. F. B., aged 41, farmer's wife living near Harrisburg, South Dakota, mother of six children, the youngest 8 years old. No especial difficulty with any of her labors or puerperia and free from history of severe illness except typhoid ten years ago and measles six years ago. I saw her first on March 3, 1916, in consultation with Dr. Herbert Day, obtaining the following history of her present illness:

Two days previously, in the forenoon, she had felt as well as usual, but after working unusually hard all morning had felt pain through the lower part of her chest and later in the day in the upper abdomen particularly in the midline, accompanied by vomiting. Dr. Day saw her for the first time that evening, finding the whole abdomen tender, pressure producing gastric pain. Rigid, tense. Pulse 120, temperature 98.4.

On the following day, March 7, she complained of the most pain about the navel and in the right lower quadrant and Dr. Day found extreme tenderness over McBurney's point with marked rigidity, some tenderness and slight rigidity in the gall bladder region and general tympanites. Pressure over the lower descending loop produced intense pain in the right lower quadrant. Pulse 80, temperature 99.4 F.

The diagnosis at that time appeared to be between cholecystitis and pyelitis possibly both. The patient had not menstruated since January 5, 1916, and was supposed to be pregnant between one and two months.

On the next day, March 8, when I first saw her the symptoms had again shifted to the upper abdomen with exquisite tenderness and rigidity in the right hypochondrium and the esophagus felt out by deep palpation as globular mass which seemingly could only be the gall bladder tightly distended. The pulse was then 110, temperature 100.1. Diagnosis acute cholecystitis of an unusually virulent type.

She was removed that afternoon to the McKean Hospital, Sioux Falls, where a blood examination showed the following: reds 4,824,000; whites 13,300; haemoglobin 85 per cent; polymorphonuclears 70 per cent; lymphocytes 3 per cent; mononuclears 8 per cent; transitionals 1 per cent. The urinalysis was as follows: color dark straw; cloudy specific gravity 1.030; reaction acid; sugar negative; albumin positive; 75 grams per liter sediment; many pus and epithelial cells; finely granular casts, urates and phosphates; colon bacilli.

Pulse 88, temperature 100.5 F. Later on the pulse was 85, temperature 100.5 F., suggesting superficially some abatement of the severity of the

infection, but the local symptoms remained unchanged and she spent a bad night and was no better the following morning, when I operated through a straight right rectus incision. I exposed the gall bladder, finding it buried in adherent omentum and large intestine, but the adhesions were recent and easily released. The gall bladder was tightly distended and of a deep red color. Near the fundus was a greenish, bluish gangrenous oval area 1.5 centimeters in the short and 2.5 centimeters in the long diameter and a short distance back a small area of similar appearance (Fig. 1, front view). The omentum which had been adherent also showed a yellowish-green slough at the point of contact. Aspiration of the gall bladder yielded dark greenish bile with no visible evidences of pus. There were no small stones about the size of grains of wheat. A small stone is seen near the duodenum, lig. f. oment. piece.

I then proceeded to remove the gall bladder, beginning at the fundus and immediately found the entire portion in juxtaposition to the liver gangrenous. I dissected it loose from the liver back to the cyst duct, which I divided between forceps and ligated at the proximal end, not without difficulty on account of the fragility of the duct which kept tearing away from the forceps all the time, bleeding freely from the cyst artery until tied. The gall bladder removed I cut together the edges of the peritoneum over it for 1/2 inch and anchored a wrapped drainage tube to the stump of the cyst duct, a drainage tube out of the abdominal incision.

Recovery was unaccompanied by incident except the sudden termination of the pregnancy on the sixth day after the operation.

The bacteriological examination of the excised gall bladder brought forth findings of the greatest scientific interest, and I take this opportunity of commending the painstaking work of my laboratory assistant, Mr. Charles A. Northrup, in this connection.

Bacteriological report on gangrenous gall bladder removed from Mrs. F. B. March 9, 1916: 1. A smear from gangrenous area showed the presence of a large plump bacillus.

Culture started from above in bouillon. Eighteen hours later stained specimens prepared and sub-cultures made in bouillon, agar-agar slant, lactose broth (fermentation tubes) and glucose litmus agar plate.

Morphology: Stained specimen of culture showed a mixed growth of staphylococci and a

moderately long plump bacillus with rounded ends occurring singly in pairs and very often in long chains

**Cultural features** (1) Moderate clouding (2) odor not noticeable (3) abundant flocculent sediment (4) evidence of gas by frequent bubbles coming to the surface.

Examination by hanging drop showed non motility

### 3 Examination of sub-cultures in 2

**Morphology** Stained specimens showed a strongly mixed growth of staphylococci and the bacillus as found in the original culture.

**Cultural features** (1) Agar agar (slant) — growth moderate, beaded, raised, white (2) glucose agar (slant) — growth abundant, widely spread, gas bubbles numerous (3) broth — similar to original culture

After twenty four hours sub-cultures for anaerobic growth were made in broth, glucose agar (stab and slant) and agar agar. These were placed in a Novy jar which contained 10 grams of pyrogallol acid and 100 cubic centimeters of a 1 per cent solution of NaOH per liter of capacity. Jar sealed tightly and incubated for twenty four hours

### 4 Examination of anaerobic sub-cultures in 3 and second anaerobic sub-cultures started

Stained specimens showed a preponderance of the plump rounded-end bacillus, appearing less frequently in chains. Stained well with all aniline stains. Gram positive and capsular stain positive.

**Cultural features** (1) Agar (slant) — small white colonies growth not abundant (2) glucose-agar (slant) — growth abundant more than on plain agar but appearance the same, (3) glucose agar (stab) — gas bubbles showing throughout media (4) broth — growth abundant cloudy sediment same as previous cultures. Hanging drop examination showed non-motility

### 5 Examination of second anaerobic sub-cultures at the end of twenty four hours resulted as follows

No change in appearance of organisms possibly the length average shorter than heretofore. Growth of cultures compared similarly to previous growths except a scanty growth was found on plain agar

6 Sub-cultures made in milk and litmus-milk and incubated aerobically with the following results at the end of twenty four hours

(a) Acid reaction in litmus-milk. (b) Gas bubbles forming. (c) Digestion seemingly slow

7 Anaerobic milk sub-cultures started with the following results

(a) Reaction same as aerobic cultures (b) Precipitation of casein without digestion

Twenty four hours later casein completely curdled.

8 Male guinea pig of average weight inoculated with 0.5 cubic centimeters broth culture of twenty four hours growth. Injection made in peritoneum. At the end of seventy two hours no apparent change in condition. Another injection of 0.5 cubic centimeter twenty four hour milk culture given in

muscles of abdominal wall. Pig died about eighty hours after second injection. Abdominal walls gangrenous and edematous. Smears and cultures taken from blood of heart fluid of abdominal wall scrapings of stomach wall and liver

**Smear 1** Fluid from abdominal wall. Many bacteria found of the characteristic form. Occurrence in pairs and single. Marked number of spores noticed

**Smear 2** Stomach. Bacteria larger occurrence single in pairs and in chains. No spores.

**Smear 3** Blood from heart. Similar to Smear 2

**Smear 4** Liver. Few present. Twenty four hours later all the cultures showed a moderate growth. Specimens prepared from all and stained with methylene blue capsular stain, spore stain and Gram's. The characteristic bacilli were found in all.

**Bacteriological conclusions** The morphological and cultural findings indicate conclusively that the organism is the bacillus aerogenes capsulatus

In summing up the features of interest in this case I would emphasize especially the fact that while gangrene of the gall bladder of ordinary bacterial causation is uncommon W J and C H Mayo having seen but one case in 433 operations on the gall bladder and ducts and John B Deaver only two in 328 operations on the biliary tract<sup>1</sup> gangrene of the gall bladder due to gas bacillus infection seems to have hitherto escaped observation no mention of any case of the kind in literature occurring so far as I have been able to discover. There is no apparent reason why it should not occur oftener with the gas bacillus a normal inhabitant of the intestinal tract, but the fact remains that hitherto it has been unknown as a causative factor in gangrenous cholecystitis. Why it should have been concerned in the present instance I do not know. One thing is certain the gas bacillus is here to be reckoned with in South Dakota as in other parts of the world, this being the fifth case in three years in which the micro-organism has been recognized in my own experience alone and while it is true that it is most commonly associated with crushing injuries of the extremities it occurs occasionally in traumatism of the trunk and the present instance shows its ability to start an acute infective process even without a predisposing injury. It is especially imperative that we recognize and be prepared to deal with this form of infection, no matter where it attacks the body since it is unquestionably one of the

most virulent and uncompromising of which we have any knowledge. The inoculation period is about forty-eight hours<sup>1</sup> and the death rate estimated at about 50 per cent.<sup>2</sup>

Hewitt. J. Am. M. Ass. 191, 1916.

Clark Stewart. J. Am. M. Ass. 21, 1917.

Hewitt agreeing with Blake and Lehey<sup>3</sup> is of the opinion that recovery is rare after the third day of the development of the infection.

J. Am. M. Ass. 191, 1917.

## THE ABUSE OF CÆSAREAN SECTION<sup>1</sup>

By J. WHITRIDGE WILLIAMS, M.D., D. T.M.O.

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TO my way of thinking one of the chief advantages of such gatherings as the Clinical Congress is the opportunity they afford for the standardization of surgical thought and practice thereby enabling one to establish a rational mean between the extreme views of the enthusiast and of the ultraconservative.

Unfortunately history shows that advances in the practice of medicine and surgery are rarely attained in a thoroughly rational manner but that a period of undue enthusiasm or even of almost reckless abuse usually precedes the establishment of the actual value of a given procedure.

From my personal experience and reading as well as from my intercourse with other medical men, I believe that we are at present going through such a stage in connection with cesarean section and I propose to utilize the short time at my disposal in giving my reasons for this conviction. Generally speaking, I consider that the operation is being abused in two ways: first, that it is frequently employed unnecessarily, and secondly that even when strictly indicated it is not always performed at the time of election, with the result that its mortality becomes needlessly high.

The prime factor concerned in bringing about this abuse is defective medical training with consequent ignorance of the wonderful adaptability of Nature and of the resources of obstetrical art. Subsidiary factors are to be found in the technical ease of the operation, and in the glamor

which still surrounds it in the professional and lay mind as well as in an underestimation of its mortality. That the abuse is primarily due to defective obstetrical training will be developed during the course of my remarks so that for the moment I shall consider only the subsidiary factors.

It must be admitted that conservative cesarean section is technically a simple operation which can readily be performed by anyone possessing rudimentary operative ability and furthermore, when followed by the complete removal of the uterus or by its low amputation it is simpler than the corresponding procedure in the treatment of uterine myomata. Such being the case cesarean section would seem to offer an incomparably easier method of dealing with complicated labor than more or less expectant treatment with eventual delivery by the unaided efforts of Nature, or after a typical obstetrical procedure. The former requires only a few minutes of time and a modicum of operative experience while the latter often implies active mental exertion, many hours of patient observation, and frequently very considerable technical dexterity. Thus far the argument seems to be so entirely in favor of cesarean section that the uninitiated can scarcely be blamed for assuming that there is no justification for protesting against its abuse, or for concluding that the ideal to be striven for should be its greatest possible utilization so that eventually only two types of obstetrical cases would need to be differentiated, namely

those ending in easy spontaneous labor or requiring some simple operation which could be performed by a midwife and those which bid fair to present a serious complication which should be promptly ended by the surgeon. Could such a differentiation lead to increased safety for the patient nothing could be said against it even though it resulted in the eventual disappearance of the trained obstetrician the glorification of the midwife and the exaltation of the skilful but unthinking cutter. It must however be admitted that such a conclusion is a *reductio ad absurdum* and is contrary to the trend of enlightened medical thought.

It is currently believed that the mortality of conservative cesarean section should not exceed that of other simple abdominal operations and probably most of those here present, who have not had a large personal experience with the operation would place it at 2 per cent. Such results however are obtainable only under exceptional conditions and I feel safe in stating that the average mortality throughout the country approaches 10 per cent. In other words the operation is much more dangerous than is generally believed.

How can this discrepancy be explained? The answer is very simple namely that ideal results are obtained only when the operation is performed at an appointed time at the end of pregnancy or shortly after the onset of labor upon uninfected women amid suitable surroundings. On the other hand the mortality of conservative cesarean section increases with every hour the patient has been in labor and approaches 10 per cent when performed after the second stage has become well established and goes still higher when the operation is undertaken upon frankly infected or exhausted women. The truth of this statement has been conclusively established by the studies of Edward Reynolds and Armand Routh, and has been borne out by my own experience. Thus while the total mortality in my series has been 8 per cent, only a single patient was lost when the operation was done at the time of election.

This rapid increase in mortality is due to

intrapartum infection, as is clearly shown by the following considerations. In the first place my experience has taught me that the convalescence is less satisfactory after the conservative operation than when the uterus has been removed. This becomes more significant when it is remembered that I do the former operation upon uninfected women early in labor while the latter is usually performed late in the second stage upon women who were already infected or who had been subjected to vaginal examinations by those whose technique was not above reproach. Such observations are analogous to the general experience in the treatment of uterine myomata the convalescence being much smoother when the entire uterus is amputated than when the tumors are enucleated and the uterus is retained. They point clearly to the conclusion that the involuting uterus offers a lessened resistance to infection and that a larval infection which would probably have done little harm had labor terminated spontaneously may lead to death if it progresses in an incised involuting uterus.

That this is not a mere theoretical deduction has been clearly shown by the histological study of a series of 45 uteri which I have amputated at the time of labor. A large fraction of these showed acute inflammation of the decidua which had clearly originated in the cervical region and was spreading upward so that in extreme cases the entire interior of the uterus had become involved. The existence of histological evidence of infection was not surprising when the patients presented an elevated temperature before operation but was very significant when observed in women who were free from fever and in whom the indication for radical operation was afforded solely by the fact that they had been long in the second stage of labor or had been frequently examined by persons with questionable technique before coming into my hands.

As the result of these considerations I think it fair to conclude that conservative cesarean section is a safe procedure only when performed early in labor and that the probability of larval infection makes the late

operation too dangerous to be undertaken except in unusual and exceptional circumstances. Accordingly I hold that it is *an abuse* to perform conservative caesarean section after the patient has been long in the second stage of labor even though she presents no evident signs of infection. Under such conditions it is advisable to attempt to terminate labor by some other procedure but if caesarean section is imperatively necessary it should be followed by amputation of the body of the uterus or by total hysterectomy.

I shall say nothing at this time concerning the employment of the several varieties of extraperitoneal caesarean section in such circumstances as I do not feel that we are as yet in a position to make positive statements concerning its merits but I have no hesitation in stating that the strictly extraperitoneal operation as advocated by Kuestner and others is a difficult procedure which should not be undertaken casually.

Thus far I have considered the abuse only in so far as it is concerned with failure to operate at the proper time and now I shall turn to a much more serious aspect of the subject namely laxity in determining the indications for the operation.

In the early days of the modern caesarean section obstructed labor was almost the only indication—contracted pelvis and clogging of the birth canal by ovarian and uterine tumors. We can all recall the old distinction between the absolute and relative pelvic indication. These were retained for many years but as the mortality gradually diminished the upper limit for the absolute indication was extended to pelvises presenting a conjugata vera of 7.5 centimeters provided the child was alive and the mother in good condition. At the same time the relative indication was so extended as to include any case in which such disproportion existed between the size of the head and the pelvis as to preclude the possibility of spontaneous labor. Naturally this indication is extremely variable and is dependent upon the size and consistency of the head and the character of the uterine contractions rather than upon the actual size of the pelvis. Thus,

it may happen that one of two women, having pelvises of the same size and children presenting identical head measurements, will have an easy spontaneous labor while the other will require a radical operation. The spontaneous outcome in the former being due to the fact that strong uterine contractions had so molded the malleable head as to adapt it to the contracted superior strait while in the latter inefficient contraction or a less malleable head rendered such a termination impossible. Consequently if manifest and serious disproportion does not exist it is necessary to subject the patient to the test of labor in order to ascertain the outcome. In this event, one waits until the cervix has become fully dilated and then ascertains the effect of several hours of second stage pain. From what I have previously stated it is evident that if the test of labor fails the time of election for a conservative caesarean section has passed, and if it is then performed the mortality will have increased to such a point as to make it questionable whether one is justified in exposing the mother to so great a risk for the problematical existence of a newly-born child.

It is therefore apparent that in the presence of the absolute indication the decision to operate is perfectly clear while it is often extremely difficult in what I have designated as borderline cases, and unfortunately for our peace of mind the latter are much more common. It is in the latter type of pelvic contraction that the greatest abuse of caesarean section occurs and I am convinced from my reading as well as from my consulting work that many unnecessary operations are performed. Each year I see patients from other cities who have been advised by presumably competent men that caesarean section is essential to a successful delivery and yet upon examination I find no evidence of excessive disproportion and some weeks later I have the satisfaction of seeing the patient delivered spontaneously.

Indeed I have been reluctantly forced to the conclusion that in many parts of the country the mere diagnosis of a contracted pelvis, irrespective of its degree is considered

a satisfactory indication for operation. This indicates profound lack of obstetrical knowledge and ignorance of the fact that from 75 to 80 per cent of all women with contracted pelvis will be delivered spontaneously if given the opportunity. In other instances the abuse of the operation can be attributed only to an obsession by the *furor operativus*.

Owing to the unusual incidence of contracted pelvis in the colored women of Baltimore and to the fact that they constitute nearly one half of the clientele of my service I have had an unusual opportunity to study the course of labor complicated by this abnormality. Excluding funnel pelvis I see each year 100 to 250 women presenting various degrees of contraction of the superior strait, upon whom I perform 10 to 12 cesarean sections and one or two pubiotomies. With my present knowledge they are all that I feel justified in doing and yet if I followed the indications adopted by some of my friends in other cities I should treble or quadruple that number. Naturally they would contend that I am too conservative but I should prefer to believe that they are too radical. Possibly the truth lies between the two extremes but, even so it would seem that there must remain a considerable margin for abuse.

Such a degree of conservatism can give ideal results for mother and child only in the hands of those who possess an extensive knowledge of the course of labor in contracted pelvis and who study each patient intensively. It would lead too far afield to describe in detail the methods by which such patients are studied and here it must suffice to state that I attempt to differentiate between those in whom such a degree of disproportion is present as will certainly preclude the possibility of spontaneous labor and those in whom it is absent. The former are treated by cesarean section at the time of election while the latter are subjected to the test of labor and are usually delivered spontaneously. In a certain proportion of cases the existence of excessive disproportion is readily established at the first examination while in a large number its presence or absence can be determined only after repeated exam-

inations at weekly intervals. With increasing experience the prognosis becomes more and more accurate but I hope that no one will imagine that I wish to claim that one can become infallible for it occasionally happens as a result of deficient uterine contractions or of a non malleable head that the expected engagement does not occur after the test of labor and one is then placed in the unpleasant predicament of having to choose between a conservative cesarean section after the time of election has passed and some other expedient. It is in such circumstances that pubiotomy offers the possibility of saving both child and mother at a minimum risk and it is probable that one of the several varieties of extraperitoneal section may prove to be of still greater availability.

It may reasonably be asked why one might not be a little more liberal with the indications and do a few more sections instead of subjecting many patients to the test of labor. The answer is threefold first that it would lead to an increase in the maternal mortality second that it would result in slipshod mental processes as the performance of any operation in the absence of a clear cut indication is a confession of obstetrical failure and third that the presence of the cicatrix in the anterior uterine wall constitutes a *locus minoris resistentiæ* which may lead to rupture in subsequent pregnancies. Provided the uterine wound has healed by first intention such a possibility is quite remote but if convalescence has been disturbed the cicatrix is frequently so thin that rupture may readily occur. To this extent I subscribe to the dictum. Once a cesarean, always a cesarean.

I have dwelt at some length upon the abuse of cesarean section in the treatment of contracted pelvis for the reason that clear cut ideas upon the subject have not yet spread through the profession and also because the abuse is more subtle than in the conditions which I am about to consider.

Following the advocacy of Lawson Tait, A. P. Dudley and particularly of Kroenig cesarean section has recently come to play a prominent part in the treatment of placenta prævia. Kroenig recommended its employ-

ment from two points of view first, on account of the appallingly poor results obtained in the Duchy of Baden following purely obstetrical treatment and second from the theoretical consideration that the lower uterine segment which forms part of the placental site is so constituted that it is unable to contract satisfactorily and thus predisposes to further hæmorrhage after the completion of labor. Koenig's suggestion has been followed by many but thus far the results reported have been inferior to those obtained by less radical procedures in the hand of masters of the obstetric art.

I am willing to admit that cesarean section is occasionally the best method of dealing with the condition more particularly in cases of complete placenta prævia associated with a rigid cervix and complicated by profuse hæmorrhage. Such a combination however is extremely rare as ordinarily the abnormal placental implantation early leads to softening and partial dilatation of the cervix. Consequently the best general treatment consists in the introduction of a Champetier de Ribes balloon which checks the hæmorrhage immediately and leads to complete dilatation of the cervix within a reasonable time after which delivery is effected by version and extraction.

This recommendation is not based upon theoretical considerations but is the result of nine years' experience in my service. During that period all cases of placenta prævia with one exception which required active interference were treated by means of the bag and but one woman was lost. Strange to say that death occurred in the only patient upon whom I have as yet felt justified in performing cesarean section for the relief of this complication but it was in no way connected with the operation as it was due to a chronic nephritis from which the patient had suffered for years.

As better maternal results could not have been obtained by any other method of treatment, our experience refutes the claims of those who postulate that cesarean section is essential to a low mortality. Furthermore the evidence becomes still more convincing when I mention the fact that our patients

were treated by a succession of resident obstetricians as well as by me. Consequently it cannot be objected that exceptional operative skill is essential to satisfactory results. I am ready to admit that equally good results might follow the employment of cesarean section by an expert, but I doubt very much whether they could have been obtained by my assistants and I am sure that they could not had the sections been performed by casual surgeons. Moreover it must be remembered that a certain proportion of hospital patients have become infected before admission so that from what has already been said concerning the general mortality of cesarean section it is evident that a certain proportion of deaths must inevitably follow had that operation been performed.

In view of my experience I can see only two arguments in favor of the frequent use of cesarean section in this condition. The first is that it may save a number of children, which would be lost by the employment of more conservative methods. This must be granted but when it is remembered that a large proportion of the children are premature and others are already dead when the case comes into our hands it must be confessed that the gain will not be very great and it is questionable whether it is sufficient to counterbalance the greater maternal mortality incident to the operation. The second argument is that delivery by cesarean section is much more expeditious, and will save the physician both time and mental anxiety. This also is true but the training of the conscientious obstetrician is such that he lays little stress upon such considerations, and until it has been demonstrated that a distinct lowering of maternal mortality will follow the procedure I hold that its frequent employment is subversive of sound obstetrical teaching and represents an unjustifiable concession to the excessive surgical tendencies of the age.

A third abuse of cesarean section consists in its increasing employment in the treatment of eclampsia. Naturally even a semi-trained obstetrician would not think of employing it if the cervix were sufficiently dilated to permit delivery by forceps or by

version and extraction or if the cervical canal were obliterated and the external os sufficiently softened to permit of safe manual dilatation. In this connection I say semi-trained obstetrician advisedly, as I have recently heard of a surgeon who performed cesarean section upon an eclamptic multipara whose cervix was more than half dilated.

On the other hand I hold that the operation is occasionally indicated in primiparous women who present an unobliterated and rigid cervix and a narrow birth canal and who show no signs of improvement after copious venesection. In such circumstances the operation is more conservative than forcible attempts at instrumental or manual dilatation of the cervix and I have utilized it with great satisfaction upon several occasions. In multiparous eclamptic women on the contrary I do not believe that cesarean section is indicated no matter what the condition of the cervix, as in such cases the birth canal is sufficiently patulous to make vaginal hysterotomy a feasible procedure. After considerable experience with the latter operation I consider it, when practicable greatly superior to abdominal cesarean section on account of the simpler and more rapid convalescence and the avoidance of the abdominal and uterine cicatrix.

From my experience I believe that once in approximately 15 or 20 cases of eclampsia, cesarean section affords the most conservative method of emptying the uterus so that what I wish to protest against is not its occasional employment, but the growing tendency on the part of many to regard it as an almost routine measure in the treatment of this disease.

A fourth type of abuse of cesarean section consists in its employment in the treatment of certain abnormal presentations such as transverse breech face and brow presentations. Naturally no objection can be raised against the procedure if the abnormal presentation is associated with such a degree of pelvic contraction or excessive foetal development as would give rise to serious disproportion so that what I am about to say applies only when the operation is performed solely on account of the abnormal

presentation. The enormity of the abuse can be best appreciated if each of the several varieties of malposition are briefly reviewed.

No properly trained person would consider for a moment the propriety of performing cesarean section if the existence of the transverse presentation were diagnosed sufficiently early to permit of a simple version and extraction. On the other hand its feasibility is sometimes considered as an alternative to decapitation in neglected cases in which the child is alive but the shoulder is so firmly impacted that version is out of the question. It must be admitted that the desire to avoid sacrificing a live child is a laudable one and should be encouraged provided it can be effected without too great danger or damage to the mother.

The fact that the patient comes into our hands with an impacted transverse presentation means that she has been neglected by an ignorant doctor or midwife and in all probability has already been infected by their ministrations. This of course precludes the employment of conservative cesarean section as the time of election has long since passed and involves the necessity of total hysterotomy or low amputation of the uterus if a successful outcome is to be obtained.

Consequently the question to be determined is whether one is justified in doing a Porro cesarean section in order to avoid decapitating a child which while still alive is already seriously compromised. To my mind the answer depends upon the social status of the woman, her desire for a living child and particularly upon whether she is the mother of several children or is pregnant for the first time. In the former event, I hold that low amputation of the uterus is a justifiable procedure, as the patient has already done her duty to the State and the possibility of further childbearing may be regarded as a matter of relative indifference. In the latter event on the other hand I feel strongly that such interference is highly reprehensible and that decapitation is preferable to forever abolishing the reproductive function of a young woman.

This question was brought acutely to my



attention by one of my assistants having elected in such circumstances to do a Porro cesarean upon a young and illegitimately pregnant primipara. I would therefore state that I consider it a serious abuse to perform a conservative section in any case of neglected shoulder presentation and that a Porro operation is no less reprehensible in the case of a primiparous woman.

Recently a considerable literature has accumulated upon the propriety of resorting to cesarean section as a means of diminishing the foetal mortality in breech presentations. I have no hesitation in stating as a general principle that I consider such a procedure little short of scandalous provided the pelvis is approximately normal and the child not excessive in size. Experience teaches that in such cases the average foetal mortality falls below 10 per cent while that of the mother is not increased over that occurring in vertex presentations so that it does not seem reasonable to diminish the mother's chances by several per cent for the sake of increasing those of the child by a corresponding amount.

I will admit however that the operation may be justifiable in the exceptional event of a first pregnancy occurring just prior to the expected onset of the menopause in a primipara with rigid soft parts should she deliberately elect to expose herself to a somewhat greater risk in order to ensure the best possible chances to her first and last child.

Similar arguments have been advanced in favor of similar treatment in certain cases of brow and face presentations and they deserve the same characterization as in the previous section.

In the absence of disproportion between the size of the head and pelvis persistent brow presentations do not occur and as the transient forms ultimately become converted into either vertex or face presentations it is evidence of profound ignorance of rudimentary obstetrical principles to suggest the advisability of resorting to cesarean section to overcome a transitory phenomenon which will take care of itself if left alone. On the other hand the discovery of a persistent brow presentation at the time of labor

indicates that the existence of the causative disproportion had been overlooked at the preliminary examination and such neglect or failure entails the unpleasant consequences, to which attention was directed in the section upon contracted pelvis.

To my way of thinking uncomplicated face presentations offer a problem approximately identical with that involved in breech presentations, which needs no further elaboration.

Finally in this connection I would call attention to the preposterous proposition of a recent writer that occiputoposterior presentations are occasionally best treated by cesarean section. Various American contributions to the treatment of this variety of vertex presentation have revealed such abysmal depths of ignorance concerning the mechanism of normal labor that one is not surprised at such a proposition, which can only be regarded as another manifestation of the defective facilities for teaching practical obstetrics which so generally prevail in this country.

The fifth and last abuse to which I shall refer consists in the exploitation of the teachings of Reynolds that cesarean section is sometimes indicated as an elective procedure in women who are constitutionally unfitted for childbearing but who present no evidence of mechanical disproportion. Doubtless, in the hands of Reynolds and a few other experts indications of this character have been productive of excellent results. I know however from my own experience that they are difficult of precise application, and from my acquaintance with other men, I am confident that they are frequently abused.

No one appreciates more than I the beneficial results which have followed the lowering of the mortality and the consequent greater usefulness of cesarean section but I feel that the time has arrived when a halt should be called upon the indiscriminate employment of the operation by many who are ignorant of the fundamental conceptions of the obstetric art. We should always bear in mind that the decision to resort to cesarean section is a confession

that Nature has failed to fulfill her obligations and that it is the duty of the conservative obstetrician to limit his interference to the greatest extent consistent with the welfare of his patients and not to be led astray by the glamour of an easy operation.

Each year in my ward classes I take particular pleasure in demonstrating patients with border line contracted pelvis who have

been delivered spontaneously and I always say that any young assistant could have obtained a satisfactory result by means of cesarean section but that a much greater degree of skill and experience is required to obtain an equally satisfactory result without it. What we need in this country are more thoroughly competent obstetricians and fewer skillful but indiscriminate surgeons

## A STUDY OF FETAL MATURITY IN UTERO<sup>1</sup>

By CHARLES B. REED, M.D., F.A.C.S., CHICAGO

THE investigation of fetal maturity before birth has all the attractiveness of a problem in Euclid and is attended by the same facility of demonstration. The proposition is advanced the tests applied, and the result set down. In due time the babe is delivered and immediately the antepartum findings are confirmed or confuted. A further interest is lent to the inquiry by the fact that while the importance of the pelvic measurements has been universally conceded and taught it has been quite as universally asserted and impressed upon students that no estimate of fetal size *in utero* nor of the cephalic diameters is in any satisfactory degree possible. Owing to this apathetic or incurious attitude such meritorious methods as we have employed in this study have been left unpracticed although they have been before the profession for years and only occasionally has some pertinacious enthusiast continued the work and furthered the cause. Without claiming for this subject a greater usefulness than we attribute to the pelvic measurements its equality in value is undeniable while the maneuvers themselves have a precision in operation and a susceptibility to proof that is far more gratifying.

Inasmuch as human gestation may vary from 241 to 336 days it is obviously essential to know when a labor ought to occur. From the standpoint of the hospital the expense must be considered seriously when a waiting patient is kept in the ward week after week

and on the part of the patient the long period of uncertainty may not only be attended by expense but by a definite strain on the nerves that impairs the health. Yet, notwithstanding these requirements very few hospital cases either from ignorance, indifference or lactation can give the time of the last menstruation or remember the date of quickening. So while it is true that labor does not occur necessarily at the time of fetal maturity yet it is highly gratifying to discover through an estimate of that maturity a probable date whereon in all fitness and propriety the gestation should naturally terminate. For the solution of obstetrical problems furthermore this knowledge is a real necessity. In placenta prævia, acute and chronic diseases of the heart, lungs and kidneys as well as in the vast field of pelvic contraction, no interference can be attempted, rationally without an acquaintance with the measurements specifically involved.

In the series of one hundred cases on which this study is based we have painstakingly employed three different methods and have secured results which, if not invariably accurate are at least practically successful in the majority of instances and highly illuminating in all. It has been no part of our purpose, however to employ the X-ray partly because this aspect of the question has been elucidated recently by Keith, but more particularly because we preferred to try more gener-

ally available instruments like the pelvimeter and tape

Before reviewing our work analytically it may be well to state that early in our investigations we abandoned the weight of the child as a reliable factor in the estimation of maturity. We may admit that long babies are usually heavy babies but is it not possible that this fatness merely indicates prolonged detention and a postmature child?

Babes put on weight in the uterus as easily and as variably as after birth, and the presence or absence of a certain heaviness should not be an evidence of maturity in the embryo any more than in the adult. Babes of the same weight may exhibit marked differences in length, while babies of the same length will vary notoriously in weight though all are mature. We must not forget moreover that heaviness is a sign of present nutrition while length is the indication of past assimilation.

The deposit of fat in the babe as in the adult, demonstrates that the intake of nourishment is not fully utilized, that the limit of elaboration has been reached under the existing conditions, and the unusable material must be stored up. In other words the child is mature and a further growth is enforced by the unaccountable delay in uterine activity.

A fat child is not necessarily a healthy child and in many instances is extremely liable to rises of temperature, but fat babies are much more difficult to deliver and show a higher mortality as well as a higher maternal morbidity than normal babies.

The average weight of the babes in this series is 7 pounds and a half. The largest weighed 9 pounds and a quarter and the smallest remained at 5 pounds and 5 ounces though both were mature. So long as the length is normal the weight may range from five to eight and a half pounds but owing to the accidents and uncertainties associated with the beginning of labor it is more than probable that a large percentage of babes (von Winckel says 72 per cent) weighing more than 8 and a half pounds are postmature and will show an excess in length to confirm the statement.

The birth of these large babies however is

a serious affair not to say dangerous, and the time is coming when as McDonald says, a 10 pound child will be a reproach to the obstetrician rather than a distinction to the parents. This brings us to the question that is bound to suggest itself as to what constitutes maturity and while our present knowledge does not permit an exact biological answer it would seem that maturity might be defined, tentatively, as that state or degree of fetal development wherein the child is enabled to surmount the perils of extra uterine life easily. But what are the signs of this maturity. If weight is unimportant, on what should a diagnosis be based?

In the present study we have found certain approximate standards of size and age to be the most reliable guides such as—

1 The length of the child *in utero* which should verge upon 50 centimeters.

2 The duration of the pregnancy as determined by careful measurements of the uterus rather than by the lapse of time since the last period or by calculation from the more important date of quickening no matter how accurately these events are known.

3 By the size of the fetal head which should measure from 8.5 centimeters to 10 centimeters in the biparietal, and from 10 centimeters to 12 centimeters in the occipito-frontal diameters.

This is the more reasonable since the wide latitude in the time of conception, the uncertainty as to the normal duration of pregnancy and the haphazard character of the onset of labor gives to the history of the case a merely confirmatory significance.

The length of the child may be obtained by Ahlfeld's method.

The fetal attitude *in utero* is one of complete flexion and Ahlfeld determined that the true length is double the length of the folded child hence the rule. Measure with a pelvimeter from the well differentiated breech of the child to the upper border of the symphysis where the head usually rests. Subtract two centimeters to allow for the thickness of the abdominal wall and multiply by two. The result is the length of the child. The same method is practiced in breech presentations.

*How accurate is the rule?* The cases herewith reported originally numbered 105 of which five were discarded for the following reasons

1 A premature detachment of the normally implanted placenta wherein the uterus was so incompressible that a good technique was not possible

2 Acute hydramnios.

3 A macerated foetus where no two results agreed

4 and 5 Women with extremely fat abdominal walls through which it was impossible to outline the babes with any certainty One had in addition a pendulous abdomen

In the 100 cases where measurements were possible, we obtained the following results

The antepartum estimate tallied exactly with the postpartum findings in 37 per cent, and varied less than 0.5 centimeters in 24 per cent of the cases. Since 0.5 centimeters is less than a quarter of an inch it does not seem unwarrantable to include these cases with the first which would give us 61 per cent of practically correct estimates

In 29 per cent the miscalculation ranged from 1.0 centimeter to 1.5 while of the 10 remaining 8 (1 being premature) had a variation of 2 centimeters 1 was 2.5 centimeters and another 4 centimeters too large. The error in this last case is not explainable. To be sure it was a breech presentation and yet one other case was a breech and the calculation was correct. In only 24 per cent of the series did the postpartum findings exceed the antepartum estimate. The rest were exact or safely below the true length

There was no definite relation in these cases between the length and the weight, for while

the largest child was 50 centimeters long and weighed 9 pounds and a quarter the smallest was 49 centimeters long and weighed only 5 pounds and 5 ounces. Since babes grow in the uterus at the rate of 0.9 centimeters a week in length the difference could not be due to prematurity in the one case nor if we accept 50 centimeters as the standard of length could there be undue detention of the other babe unless we could prove that the 50 centimeters length had existed for some time.

Drs. O Connor and Kokilase who made many of these examinations at Wesley Memorial Hospital found all the methods easy to apply and increasingly accurate with use. A specimen chart is herewith introduced to illustrate our system of operation. In the sixth column the larger number represents the result of the direct occipitofrontal measurement and the smaller figure our estimate of the biparietal diameter. In the ninth column the corresponding figures show our postpartum findings

The McDonald measurement is really an estimate of maturity although originally put forward as a means of determining the advancement of the pregnancy. It is hardly fair therefore to bring it into competition with the Ahlfeld which is so distinctively a maneuver for obtaining the length of the foetus. However the advancement of the pregnancy is an integral part of the problem of foetal maturity and the McDonald measurement is an important factor in the solution. Therefore for the benefit of those who are not familiar with his work a summary of the McDonald technique is presented

One hand holds an end of the tape at the upper border of the symphysis. From this point the hand carries the line upward, following the rotundity of the uterus closely until it dips beneath the ensiform cartilage. Here the finger tips are pressed down until the highest limit of the fundus is attained. The tape meanwhile held between the thumb and the index finger does not follow the dip to the very bottom but the scale is read at a place in exact line with the upper border of the fundus and an inch or an inch and half above it.

In multiparae the uterus must be brought into the median line by lateral pressure and the long axis of the child made parallel with the long axis of the mother while the measurement is taken. Inasmuch

Patient name, Mrs. Anna Goldstein, age 9. Neither time of last menstruation nor date of quickening was known.

Date	Ahlfeld	Estimated Length	McDonald	Estimated Period of Pregnancy	Occiput Front Diameter	Delivery	P.P. Length	P.P. Diameter Biparietal	P.P. Weight
3/30/06	43½	43	38	8	9½ 7½				
4/1/06	46	48							
4/9/06	46	48			¾				
3/10	40½	40	3	9	8½	May	48 3	8 1	3½

as judgment and experience are required in every instance to decide just how much pressure must be used by the fingers holding the upper end of the tape. It would seem as if some means should be devised to avoid this second variable factor but it is not clear at present just how it could be done.

Assuming a normal pregnancy to extend through ten lunar months McDonald claims the fundus should be 35 centimeters above the symphysis at term. Then since the child grows at the rate of 3.5 centimeters per month (after the fifth month) 35 is divided by 3.5 and the result is 10 or the month of the pregnancy.

Suppose the tape gives 34 centimeters as the height of the fundus then 34 divided by 3.5 equals 9.7 months as the period of the pregnancy.

McDonald states that in every instance where the tape measures 35 centimeters, the child is certainly mature and the woman at term. Our observations bear out this statement in fact we were impressed with the feeling that McDonald allows a little more margin than is actually necessary.

In our series we used the Ahlfeld and McDonald methods as checks upon each other and for the most part found them mutually corroborative although in a certain percentage of cases the McDonald was low when the Ahlfeld was exact.

We found

14 cases with a McDonald of 34 centimeters and a postpartum length of 49.3 centimeters and a weight averaging 6 pounds and 14 ounces.

6 cases gave a McDonald of 34.5 centimeters with a postpartum length of 50.8 centimeters and a weight averaging 7 pounds.

2 cases gave a McDonald of 35 centimeters, a postpartum length of 50.8 centimeters and a weight averaging 7 pounds and 6 ounces.

9 were above 35 centimeters and gave an average postpartum length of 51.5 centimeters and a weight of 8 pounds and 5 ounces.

Thus 51 per cent of the whole were 34 centimeters or more in length and averaged 7 pounds and 4 ounces in weight.

Of the whole number 50 per cent had a fundal height of 32 to 33 centimeters before delivery although they were normal babies and mature on postpartum examination. These 50 cases were also estimated by the Ahlfeld method either exactly or within a centimeter which would seem to confirm the theory that the McDonald allows a trifle too much latitude. Indeed our observations on the height of the fundus at term conform more nearly to the results obtained by Varner and Spiegelberg who report 33 and 35.7 centimeters respectively.

Again the largest child with a weight of 9 pounds and 4 ounces and a length of 50.0 centimeters gave a

McDonald of only 33.5 centimeters while the largest McDonald 37 centimeters, resulted in a child of only 8 pounds and 11 ounces though it was 53 centimeters long. The Ahlfeld estimate in both instances was correct.

Without taking the size of the uterus into consideration these two cases in themselves draw attention to the lack of relation between the size of the foetus and its length, or if we may venture the statement, its maturity. It is also interesting to note that where the measurement varied from 34 to 35 centimeters the weight varied but half a pound, but as soon as 35 centimeters was exceeded, the average weight jumped at once to a pound more.

By means of the Ahlfeld and McDonald measurements twins were diagnosed in two instances and the two sets of heart tones were subsequently identified one after an hour's search and the other after intermittent examination for three days.

With due appreciation of the assistance really conferred by the McDonald method, it has in our experience seemed a little less reliable than the Ahlfeld. On the other hand the procedure is easy to apply and increases in accuracy the more it is used.

The estimate of the fetal head diameters has a more comprehensive interest, since it not only helps to establish the maturity of the child but it assumes an immense importance where the pelvis is contracted. This problem has seemed so complicated that few have cared to work on it, and especially in recent years, if we may judge by the literature, the attention directed to it has been scant and the lack of interest discouraging. Nevertheless the method of Perret is well worthy of trial and confidence. The occipitofrontal diameter in most cases lies near at hand except for the interposition of the uterine and abdominal walls but the biparietal which is most important, is quite inaccessible and must be secured by indirect means. The theory of the method is based upon the existence of a certain relationship between the occipitofrontal and the biparietal diameters. A brief description may not be amiss. The occipitofrontal diameter of the head as it lies across the inlet is measured directly with the pel-

vimeter and a figure that varies with the size of the occipitofrontal is subtracted to give the biparietal. As originally presented an allowance is made for the thickness of the abdominal wall as in the Ahlfeld method, but Stone discovered the results were more accurate if this deduction were omitted.

Then too it was Perret's idea to subtract a fixed figure of 2.5 centimeters from the required occipitofrontal to get the biparietal diameter. McDonald found that if this were done the procedure would be exposed to unnecessary inaccuracies and he proposed a sliding scale whereby the deduction should vary as the occipitofrontal diameter varies. Thus an occipitofrontal of 11.25 centimeters has 2 centimeters subtracted to obtain the biparietal while an occipitofrontal of 12.0 centimeters is decreased by 2.5 centimeters.

At Wesley we have found that McDonald's table of deductions is good in principle but should be so extended that for occipitofrontal diameters of less than 11.0 centimeters only 1.5 centimeters should be subtracted. It is questionable too whether it may not be advisable in future to deduct more than 2.5 centimeters from occipitofrontals greater than 12.0 centimeters but these heads are relatively rare and may be left for the present.

The rule therefore with the appropriate though arbitrary deductions for the different occipitofrontal diameters obtained may be thus stated:

By deep pressure over the inlet, obtain the occipitofrontal poles and measure their separation with a pelvimeter. Then to estimate the biparietal diameter from an occipitofrontal of 10.0 centimeters deduct 1.5 centimeters an occipitofrontal of 11.0 centimeters to 11.25 centimeters deduct 2.0 centimeters 11.5 centimeters deduct 2.25 centimeters 12.0 centimeters deduct 2.50 centimeters and the result is the biparietal diameter.

*How does the rule work in practice?* Owing to the head being too deep for examination the abdomen too thick or too hard or on account of such foetal anomalies as prematurity or maceration only 85 tests were obtained.

Of these 31 or 36 per cent, tallied exactly with the postpartum findings and 27 more 31.7 per cent were within 0.25 centimeter

In many pelvis where extraction by the natural passages could be properly undertaken this trifling error would be negligible and we can therefore, combine these results into one group. We get then 67.7 per cent of the examined cases where the biparietal diameter was estimated within 0.25 centimeter or an eighth of an inch. Of the rest 22 or 25.8 per cent were within 0.5 centimeter and the five remaining were within 1.0 centimeter.

Thus in 94 per cent of our cases we obtained the biparietal diameter either exactly or within 0.5 centimeter which is well inside the workable limits though not ideally correct.

Another interesting phase of the investigation remains. How nearly do we secure the occipitofrontal diameter by direct measurement, when no allowance is made for the thickness of the abdominal wall?

We found the results to correspond exactly in 40 per cent and within 0.25 centimeter (one-eighth of an inch) in 34 per cent of the cases or if we may be permitted again to unite two groups in 74 per cent of the whole number. Twenty-four per cent were within 0.5 centimeter and 2 per cent within 1.0 centimeter. McDonald's experience was even better since his estimates tallied exactly with the postpartum findings in 72 per cent of his cases.

# CONCLUSION

As a consequence of this study the writer is convinced that we have in these procedures the means of obtaining with reasonable accuracy a knowledge as to the proximity of foetal maturity and even as to the existence of postmaturity.

The Ahlfeld is workably correct in 61 per cent and the McDonald in 51 per cent of the cases. It is possible another series might give better results with the experience acquired especially with the McDonald for the originator of the method gets a higher percentage of correct estimates than we do. Moreover in those cases where the findings are inconclusive the information obtained is so valuable that it cannot be disregarded in justice to the patient.

The Perret is even more needful if possible since it reveals the despotic biparietal diameter with practical accuracy in from 68 per

cent to 94 per cent of the cases. In contractions of the pelvis furthermore where all these diameters and measurements are most necessary we find these methods are easier to apply and more generally reliable in results.

An extreme Ahlfeld or an extreme McDon usually means a large child but it should also arouse a suspicion of twins.

A sudden diminution of the Ahlfeld or the McDonald measurement after being regularly observed may be the first indication that the head has entered the pelvis. When the head is in the pelvis the Ahlfeld and the McDon

ald are not so reliable and the Perret is unobtainable, but for the same reason they are unnecessary.

We believe these procedures are entitled to far wider employment and more confidence than they have received hitherto and that they should be regularly practiced as well as taught in the schools.

Finally the writer wishes to reiterate for emphasis his opinion that mere fatness in many cases is not so much a sign of foetal maturity as of overlong detention in the uterus.

## THE USE OF DESICCATED PLACENTA

WITH SPECIAL REFERENCE TO THE ADMITTING OF PREGNANCY<sup>1</sup>

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**T**O explain my reason for administering placental extract to pregnant women a theory or theories must be advanced to determine the action that the substance in most probability will have then by its administration to prove that this action has taken place.

Leo Loeb in 1909 showed that the corpus luteum sensitizes the endometrium for the reception of the fertilized ovum. Thus action is the lowering of the resistance of the host or at least, the uterus of the host to this foreign protein (the ovum) thus making it possible to exist and not be absorbed. Now that the ovum is imbedded and growing a relative immunity must be established by the pregnant woman against the products of conception.

The growing ovum acts as an antigen and stimulates the host to the formation of antibodies. This is in accordance with Ehrlich's theory of immunity with which we are all more or less familiar.

A. H. Curtis<sup>2</sup> demonstrated the death and absorption of living ova in the uterus of the guinea pig and the rabbit, by the subcutaneous injection of placental extract.

Rabbit 1. Dosage 40 cubic centimeters. Abortion of one one-third developed macerated fetus on third day. Killed. Five fetuses in store in varying stages of absorption. Corpora lutea absent. No signs of infection.

Rabbit 2. Dosage 25 cubic centimeters. Abortion of five three-quarters grown, slightly macerated fetuses on fourth day. Killed. Corpora lutea absent. No signs of infection.

Rabbit 3. Dosage 20 cubic centimeters. Dose repeated two days later. Rabbit well. Killed four days after second injection. Seven corpora luteum cysts in left ovary four in right ovary. These are the largest corpora luteum cysts yet seen in a rabbit. Uterus contains four young fetuses in each horn all partially absorbed. No signs of infection.

Rabbit 4. Dosage 20 cubic centimeters. Killed two days later. Uterus boggy. Contains half dozen milky accumulations suggestive of absorption of ova.

Guinea pig 4. Dosage 4 cubic centimeters. Aborted three nearly mature fetuses on third day. Discharged in good condition.

Guinea pig 5. Dosage 3 cubic centimeters. Aborted three two-thirds developed fetuses on second day. Discharged in good condition.

Guinea pig 6. Dosage 2 cubic centimeters. Littered two pigs within 24 hours. One died same day other healthy. Mother discharged in good condition.

The results of these experiments may be explained by the fact that the injection of placental extract increases the resistance or

<sup>1</sup> J. Am. M. Ass. 1909, Oct. 30, 247.

<sup>2</sup> Surg. Gynec. & Obst. 19, 4, 23, 1909.

Read before the Chicago Gynecological Society January 9, 9. (For discussion see p. 710.)

raises the immunity of the host to such a degree that the existing balance is altered causing death and lysis. Even in older pregnancies the action is sufficiently strong to cause death of the mature foetus and resulting still birth.

One case of my series a woman with pre-eclamptic toxæmia, was given 15 grains of desiccated placenta orally for a period of 10 or 12 days. A still birth resulted with the important fact that toxic symptoms of the mother became no worse during administration and the blood pressure dropped about 20 millimeters of mercury.

From Ehrlich's theory we may reasonably assume that if the host does not react to the antigenic action of the growing ovum such a condition as toxæmia will result, and if the inhibiting action against the invasion of the ovum were diminished, it would follow that the syncytium would tend to grow more profusely.

G. Acconci<sup>1</sup> has demonstrated that in the placenta of the toxæmia of pregnancy there is an *intense atypical proliferation* of the syncytium which penetrates the villi. In other cases conglomerations of the villi are formed that lead to disturbances in the circulation in the subdecidua by degeneration, fibrin formation and stratification.

The question next arises is the condition not due to the diminished proteolytic ferment in the blood? The Abderhalden reaction is negative or very weak in toxæmia of pregnancy (De Lee). This indicates that the ferments are diminished in a greater proportion than the antiferments for under normal conditions Singer and Quantz<sup>2</sup> have shown that Substrates (i.e. placenta tissue) neutralize antitryptic bodies in the blood serum thus permitting fermentation of the nitrogenous constituents of the serum. This autolysis if not carried too far will cause a positive Abderhalden reaction.

If the ferment content of the blood is lower than in normal pregnancy then the splitting of toxic split products in the serum to lower and non toxic forms is diminished and we have an accumulation of toxic substances.

This has been definitely proved to be the case in lobar pneumonia before crisis by the work of Jobling and Peterson.<sup>3</sup>

These findings suggest that perhaps the absorption of fibrin or products of early autolysis may be the cause of toxæmia.

Very early in the growth of the ovum there is first a degeneration of the trophoblast<sup>4</sup> and in Peter's ovum there is in some regions what is almost entirely degenerating syncytium.<sup>5</sup> Bryce and Teacher describe a zone of coagulated necrotic fibrin around the ovum. Typical fibrin striae probably occur only after the cessation of the phagocytic activity of the trophoblast. Degeneration may be observed according to R. Bonnet<sup>6</sup> in the syncytium in younger stages of ova. In older ova as described by F. Marchaud<sup>7</sup> There are transitions of syncytium into fibrin. Nita-buch's fibrin stria appears in the transitional zone between the maternal and foetal tissues. There are other deposits as for example the Langhans stria which lies close beneath the chorionic plate. This last appears between the syncytium and the connective tissue of the villus and is of foetal origin.

J. Young<sup>8</sup> pointed out that toxæmias of pregnancy are due to the liberation of the products of early autolysis of the placenta because they are associated with recent infarction of the placenta, and the placenta is so constructed that the products of the dying patch can pass directly into the blood stream.

I think that the disturbance in circulation, causing this necrosis and infarction aside from accidental hæmorrhage may be explained in part, by the observations of Acconci previously mentioned. Young further states that these facts suggest that toxæmias are due to autolytic products of dying placental tissue and by imitating the process occurring *in utero* he is able to isolate from the healthy placenta, soluble materials that when injected caused (1) convulsions (2) peripheral focal necrosis in the liver and

J. W. Jobling, W. T. Peterson, and A. A. Egglish, J. Exp. Med. 5, xiv, 904.

Kettel and Mall. Human Embryology p. 22.

Ibid. p. 3.

Messersch. J. Geburtsh. Gynæk., 1903 xviii.

Beobachtungen über den menschlichen Eiern. Anat. Hist. vol. xii, 191.

J. Obst. & Gynec. Brit. Emp. July 4, 1914.



(3) degenerative lesions in the kidneys especially in the convoluted tubules

Deficiency in the action of the thyroid has been suggested as a cause of toxemia. Howell says that one of the functions of the thyroid gland is to neutralize or destroy toxic substances formed in the metabolism of the rest of the body. Rogers and Garnier Hunt and others have shown that the thyro-parathyroid is antagonistic to bacteria toxins and certain other poisons as well as toxic waste products. In summing up Sajous says that the physiological action of thyroid preparations may be summarized as follows:

1. They enhance oxidation by increasing the inflammability of the cellular phosphorus and by enhancing the functional activity of the adrenals

2. Their power to enhance the inflammability of cellular phosphorus extends to pathogenic elements waste products etc.<sup>1</sup>

The thyroid secretion then must rid the body more quickly of toxic waste products by increased oxidation

I have given desiccated placenta because (1) if the condition is due to a lowered immunity of the host to the growth of the syncytium as seems probable by the work of Acconci it may stimulate by acting as an antigen. The work of Curtis would also bear this out. (2) If the proteolytic ferment is lower than normal as demonstrated by the negative Abderhalden reaction, it may increase the ferment content of the blood. (3) The placenta may be a gland of internal secretion, and it may increase the action of the thyroid and adrenals and by so doing hasten the oxidation of partial protein, split products being thrown into the circulation

I have collected thirteen cases of vomiting of pregnancy which have occurred at different

periods during gestation. One or two of these developing later in pregnancy as they did might have developed into the pernicious type had they been allowed to continue. Of these thirteen cases two were lost sight of. Of the remainder seven stopped vomiting within a day or two and the nausea soon disappeared. Two improved and remained fairly free from nausea although the administration of the extract had to be continued over a longer period of time. In the remaining two cases the results were not satisfactory one was definitely neurotic.

At my suggestion Dr. De Lee has used the extract in six cases with good results in three and varying success in the remainder. He has also used it in two cases of urticaria of pregnancy from which prompt and lasting relief was obtained.

I will in brief give two case reports to demonstrate vomiting at different stages of gestation

CASE 1. Mrs. T. III para, age 34, six months pregnant. She menstruated regularly during the first three months of pregnancy. During the fourth month she had an attack of bronchitis. In the sixth month she suddenly developed morning sickness which in the course of two or three days developed into uncontrollable vomiting. A capsule (3 grains) of desiccated placenta was given three times daily with only enough water to facilitate swallowing. Within two days she had stopped vomiting and was delivered at term.

CASE 2. Mrs. H. II para age 36 six weeks pregnant complains of morning sickness. Three five grain capsules of desiccated placenta given daily for three days with complete cessation of symptoms.

In conclusion I wish to state that on account of the great scope of this subject, it is not the intent and purpose of this preliminary report to include the physiology, biochemistry or histopathology of the above mentioned conditions.

# DEPARTMENT OF TECHNIQUE

## HARELIP

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FACIAL defects congenital or acquired traumatic or pathologic are so conspicuous as to be not only an unceasing source of embarrassment to those who have them but an obnoxious spectacle to one's associates. Therefore they offer a twofold demand for correction. And this correction deserves to be not simply an attempt to relieve the disfigurement. It should, to accomplish the end desired, be the best possible correction. The net result, while primarily cosmetic, must not lose sight of the fact that function must be maintained or improved according to the necessities presenting. The correction of such defects as are described below is not so simple a matter as one might judge by the readiness with which so many are undertaken. The inferior results often seen results that should cause one to prefer the original deformity are loud witnesses to the truthfulness of the above statement. Such failures grow naturally out of two factors: one is inexperience, the other failure to recognize certain fundamental elements pertaining to all plastic work, and certain others that apply only to the particular site of the lesion to be dealt with. This statement applies with especial relevancy to correction of harelip.

This discussion has been undertaken not with a purpose to review the literature but to illustrate from practical experience the factors which have made success more sure. The object undertaken is the correction of harelip alone or associated with cleft palate. The cases on which this paper is based number something more than two hundred. The age of the patients varied from two weeks to more than forty years.

Harelip may be complete by which it is understood that the cleft extends from the free margin of the lip into the nose so that the attachment of the ala nasi to the septum is severed and the ala flares outward and is flattened often even depressed. If the alveolus is cleft there is a consequent deviation of the nasal septum toward the side of the cleft, the degree of which depends upon the advancement of the os incisivum. Harelip may be incomplete in any extent, from

the slightest gap in the free margin of the lip to the narrowest band separating it from the anterior nares. The lesser degrees of the incomplete type are not usually associated with deformity of the nostril but may be occasionally and thus especially when there is an associate cleft palate dividing the alveolus of course, with increasing degrees in the harelip there is a greater chance of disfigurement of the nostril and deviation of the septum.

Harelip complete or incomplete may be either unilateral or bilateral and the bilateral type as the unilateral type, may be associated with or occur independently of cleft palate. What has been said of the unilateral complete or incomplete type not associated with cleft palate involving the alveolus is true of the bilateral type similarly free from clefts in the alveolus. The defects become symmetrical. Usually in these double cases there will be little or no deviation of the septum. However when bilateral cleft of the alveolus occurs a new most difficult phase presents itself. The nostrils flare outward so badly sometimes as to give the impression that the nose is greatly diminished in size. The septum fortunately is straight. The os incisivum juts forward to the tip of the nose and occasionally as much as one-half inch beyond the tip. The small median portion of the lip covering the upper surface of the malposed os incisivum, the part that should normally form the philtrum is not continuous from the posterior margin of the nasal septum as it should be, but arises at some point usually considerably anterior to the posterior limit, and often from the skin at the very tip of the nose whence it turns abruptly forward to cover the os incisivum. This represents the acme of harelip and cleft palate disfigurement.

There are as hinted at above certain fundamental facts that obtain in all plastic work. They are, therefore necessary in correction of harelip and its associate disfigurements. They are so simple, so universally known that one might apologize for even referring to them were it not true that oversight of them is responsible



Fig. 1 Incomplete harelip associated with left of hard and soft palate.  
Fig. 2 Same case ten days after operation.



Fig. 3 Bilateral incomplete harelip.  
Fig. 4 Same as Fig. 3 four weeks after operation.

for many, if not most, of the failures in correction of facial defects. They are (1) That a sufficiently wide raw surface should be made on each coapted part to guarantee union of the full thickness of the lip. Simple as this proposition is, the great frequency of a groove along the cicatrix in the lip with a corresponding groove on the mucous side eloquently witnesses that it is often forgotten. (2) The tissues should be clean cut and their blood supply and the integrity of the cells of the raw surfaces should be reduced as little as possible. No ligatures should ever be applied to the cut surfaces; they are unnecessary. If ligatures must be used they should be passed into the tissues of the lip away from the line of union. (3) The coapted surfaces must fall easily together, no matter how much dissecting is required to relax them, or how much time it requires to narrow the width of the harelip, whether during or prior to the operation. (4) Relaxation must be maintained continuously from completion of the operation until healing is perfect. Function

voluntary or involuntary must not be allowed to disturb the line of union. The large number of partial failures and occasional complete ones indicate the need especially for the last three items.

The question as to the time of operation in these cases is an important one, more important when there is an associated cleft palate. It should be understood that every harelip should be corrected regardless of the patient's age, and so far as simple, incomplete harelip is concerned its correction should give uniformly good results regardless of age. But where the nostril, the nasal septum and the alveolus enter for consideration the results usually are better the younger the age at which the operation is done. However, this should not be accepted as a disparagement to those who have reached maturity as may be seen from a glance at the accompanying illustrations. When the surgeon may elect



Fig. 5 Bilateral harelip and complete cleft palate. The maxillary had been removed when an infant.  
Fig. 6 Same case two months after correction.



Fig. 7 Incomplete harelip with marked labial groove.  
Fig. 8 Same as Fig. 7 after operation.



Fig. 9. Incomplete harelip

Fig. 10. Same as Fig. 9 ten days after operation.

the age at which he will operate he will make no mistake in choosing to operate at the earliest date possible. This usually means when the child is about three or four weeks old i. e. as soon as the mother is able to travel. The best results in cases of cleft alveolus deviated septum and protruding os incisivum must be sought before the child is six months old while the bones are still in the cartilaginous state and pliable. Waiting until a later age necessitates cutting to get the alveolar arch into position and millates against correct contour of the arch inasmuch as cutting permits rotation at one point only.

Ether anaesthesia is employed in all cases and no complications or accidents have been incurred in my cases. I have on one occasion been compelled to do a major operation under ether anaesthesia lasting one hour on a child nineteen hours old. There was no difficulty throughout and the child recovered uninterrupted. This is mentioned on account of the frequent question as to how young a child can take ether safely.

The special items in this line of work to be considered are just as important as the general rules of plastic surgery laid down above for it is altogether possible that one may be able to get a perfect operative result with so poor cosmetic and functional results as to render the operation worse than worthless, for it is always more difficult to reoperate on harelip cases than to do the work at first. Hence we are compelled to get not only a union of the cleft, a closure but we must make the patient look like a human being. The special items to be considered are (1) to give an even margin to the lip (2) to reconstruct the anterior nares so that they will be of equal size (3) to place the alae in such position that they will appear symmetrical i. e. so that a horizontal and a vertical transverse plane will intersect the alae on the two sides of the nose at corresponding points (4) to give proper prominence to the upper lip without undue protrusion.

1. Why even a casual observer should see so many corrected harelips with either a groove to which reference has already been made or a



Fig. 11. Three-weeks-old infant with complete unilateral harelip and cleft palate

Fig. 12. Same as Fig. 11 two weeks after correction of alveolar arch and lip

V shaped margin or a drop of the lip on one side or the other of the scar like a single stair step it would be impossible to guess. But one thing we may be sure of namely that the lip was not properly cut, or was approximated incorrectly or was not held in approximation sufficiently long. This defect is such that it is but little better than a harelip. This same accident has evidently been happening for a long time for from time immemorial surgeons have instructed us to approximate the margin, the vermillion border of the lip first. I do not think it necessary to follow this rule except in cases of incomplete harelip. In complete cases it is probably better to approximate the nostril first. At any rate a much better rule would be to approximate the margin of the lip correctly. This cannot be done by any plan that unites the two sides of the



Fig. 13. Five year-old girl with bilateral incomplete harelip.

Fig. 14. Same as Fig. 13 eight weeks after operation.



Fig. 5



Fig. 6

Fig. 5 Unilateral harelip and left palatal cleft in girl of sixteen

Fig. 6 Same girl eight days after operation. Showing correct protrusion of the margin of lip



Fig. 7



Fig. 8

Fig. 7 Incomplete harelip, marked groove, and complete left palatal cleft

Fig. 8 Same as Fig. 7 taken six weeks after operation

cleft into a straight line for when healing occurs and contraction of the cicatrix follows the inevitable result is no matter how satisfactory the work from a technical standpoint. On the other hand, the essential of gaining a natural appearance of the lip depends first on closing in an angular or curved line and second in making slight overcorrection at the margin i.e. suturing the margin so that it bulges downward at this point. All the illustrations shown are corrected in this manner.

2. The size of the nostrils can very easily be made unequal. It might be more properly stated that it is difficult to make them equal in size owing to the fact that when the ala is approximated to the septum its flattened surface is almost

certain to buckle usually outward and render comparison with the other round or oval nostril difficult. The best rule to follow here is to prepare the septal surface first and remove a minimum thickness from the alar surface. The buckling that occurs when the nostril is sutured need cause no concern it readjusts itself.

3. In mentioning this item of symmetrical nostril reference is not made to the size but to the position of the alar. It is an easy matter to suture the ala to the septum in such a manner that it is higher or lower usually the latter than on the normal side. This is the reason assigned for the statement already made that it is perhaps better in complete harelip to suture the nostril first in preference to following the old rule of suturing the margin of the lip first. It is also necessary in suturing the ala that the two sides appear posteriorly the same distance from the margin of the septum.



Fig. 9



Fig. 10



Fig. 11

Fig. 9. Child on whom the lip, nose and alveolus are corrected three months before complete bilateral harelip and cleft.

Fig. 10. Unilateral harelip and cleft palate six months after operation.

Fig. 11. Unilateral harelip and cleft palate. The lip and alveolus were corrected one year ago.

4. There is no part of the result of harelip and cleft palate work that adds more to the good appearance of the patient than correct prominence of the upper lip nor is there anything more capable of giving him the foolish face of an imbecile than dealing with the mouth in such a manner that the upper lip appears depressed giving the nose undue prominence at its lower border and, in profile causing the patient to look as if his upper jaw had been forced back a half inch or so into his face. Obviously these items pertain only to those cases where harelip is associated with unilateral or bilateral cleft palate. In bilateral cases this feature is doubly important.

Correct prominence of the lip is intended to signify that the os incisivum shall be replaced and held into position until healing occurs and yet not show too great prominence of the lip or too much depression. The latter is the worse. In young infants (under three months of age) when the cleft is unilateral all that usually will be required is to freshen the two alveolar margins and spring the os into position by manual pressure and maintain the new position by wire that passes through each superior maxilla and the hard palate, encircling the cleft completely with an occasional additional suture.

If on the contrary the opening through the alveolus is bilateral the restraining influence is entirely lost and the os incisivum is juttred forward in all degrees even until it extends beyond the tip of the nose. If this protrusion is slight the edges of the cleft on each side may be pared and the bone forced into position and held by the encircling shotted wire as was suggested above for unilateral cleft. If the bone cannot be replaced in this way or if such reposition enforces rotation of the os incisivum on its transverse axis causing the upper incisors to be erupted so that their free margins upon occlusion would lie on the buccal rather than the labial side of the lower incisors it will be necessary to resect subperiosteally a sufficient segment from the nasal septum to make correct reposition easy. When a sufficient resection is done the os may be replaced by fracture of the remaining bony pedicle. This releases all bony attachments and renders it necessary to suture it to the maxillae on either side in addition to the circular wire suture otherwise backward depression of the free margin will almost invariably occur.

One serious difficulty presents in severe cases of protrusion where the os incisivum is directly attached to the anterior margin of the nasal septum at the very tip of the nose. This difficulty

consists in the fact that reposition of the os as outlined above carries with it the tip of the nose and produces an incorrigible and hideous flatness of the nose which neither future development nor surgery will improve materially. To avoid this it is necessary to dissect the small segment of lip covering the anterior (upper) surface of the os away from the underlying bone leaving it attached by the pedicle to the tip of the nose then to sever the os incisivum from the nasal septum far enough backward to allow for normal nostrils and to suture the pedunculated portion of the lip to the lower edge of the septum thus affording a cutaneous rather than a cicatricial border between the restored nostrils. If the pedicle is long enough to reach farther backward than this feature requires the excess should not be sacrificed, but should be incorporated in the lip after the arch is corrected.

In cases in which at a previous operation the os incisivum has been sacrificed the contour of the face (lip) can be restored only by transplanting a pedunculated section from the nasal septum so that it occupies a space between the margins of the maxillae or by wearing a plate or bridge to fill this space.

In all cases of harelip surgery it is unwise to apply dressings. The only dressing necessary is adhesive straps applied in such manner as to avoid all possibility of tension being made on the line of sutures until healing is complete.

Attention is called to an important result obtained incidentally in this work which can almost invariably be observed in individuals who have been operated upon after reaching the age of self consciousness. The whole countenance changes for the better as can be observed by covering the lower half of the face before and after operation and comparing the upper halves. So much for the psychological effect of harelip and its correction.

## SUSPENSION IN BRONCHOSCOPY AND ESOPHAGOSCOPY<sup>1</sup>

BY ROBERT CLYDE LYNCH M.D. F.A.C.S. NEW ORLEANS, LOUISIANA

IN my earlier writings and correspondence with my colleagues I have stated that the use of suspension was not an essential in bronchoscopy or esophagoscopy and I am still of this opinion in adult subjects where the reason for the use of the tubes is not a foreign body impacted in

the larynx or just behind the cricoid in the esophagus. In these instances even in adults the suspension will facilitate the removal of such a foreign body better than the spatula or the tubes alone. But in children and infants I have been using the suspension for the purpose of the in

roduction and manipulation of the tubes with such satisfaction that I feel now that it is becoming a very essential factor in this class of work.

1. Infants and young children are the most ideal subjects for suspension because of their natural muscular underdevelopment, their flexible necks, and because of the short distance from the upper teeth to the larynx.

2. It is in infants and young children that the greater percentage of our foreign body cases occur and it is in these also that we fear most the reactive inflammations and swellings due to our manipulations.

At times it has doubtless been your experience as it has been mine to remove a foreign body successfully with the bronchoscope only to be called again to relieve the subglottal edema by a tracheotomy, a most disheartening circumstance.

It is the opinion of the continental Europeans that per-oral endoscopy is not practical in infants and young children up to four years of age but that tracheotomy should be done in these cases. One has but to see Jackson at work or to read the American literature to be convinced to the contrary, that per-oral endoscopy is the procedure of election in infants and young children provided one has developed that technique which will permit the passing of the tube through the glottis with the least amount of traumatism and suspension aids this to the greatest degree.

I also agree most heartily with Jackson in his postulate on anesthesia in young children and never in infants. If there is one real contraindication to general anesthesia it is in the case of a baby with insufflated foreign body which is producing some dyspnea.

For bronchoscopy in infants and young children the head of the table is not dropped as for the regular technique, it being more convenient to have the table flat. Just sufficient extension by moving the horizontal crane outward is made to bring the posterior two thirds of the larynx into view; there the neck is straightened by the elevation of the trailing crane and we have the posterior two-thirds of the larynx well in view in many instances with the child's head hardly elevated from the table.

The child patient is prepared by being wrapped firmly in a sheet and the crane so adjusted that we may procure flexion of the head rather than extension for you will remember that we are not anxious to see the anterior commissure now but to gain sufficient room for the passage of the tube. One can use a short spatula and follow along the base of the tongue using the tube to elevate the

epiglottis though I much prefer to introduce the spatula that it picks up the laryngeal face of the epiglottis and brings into view the interior of the larynx. A solution of 5 per cent cocaine is now applied to the upper part of the larynx only being sure that the trachea receives none of the anæsthetic fluid on account of the possibilities of diminishing the cough reflex nature's only method of ridding its bronchial tree of excessive secretions. The surface of the larynx and vocal cords are next covered with sterile vaseline, to permit of easy passage of the tube.

With the larynx thus before you, prepared in a surgical way for the passage of a tube or any other instrument it is an easy matter to slip the bronchoscope or œsophagoscope into its respective opening without in the least manner traumatizing the part.

In infant and young children one will usually inspect the parts first and in some instances remove the foreign body without other aid. I append brief reports of two cases to illustrate.

By fourteen months old, undernourished, underweight, somewhat pale and puffy but typical foreign body cough. History of suffocation of terminal seed some week ago. Three previous attempts were made, removal is made, the object being lost. On suspension of the child the seed is seen to be loose in the trachea. Flexion is resorted to, but even the cords separate and the child made to cough, then the seed flew out of the mouth. It is found no tube or other instrument entered below the cords. The child is so ill that it yet must come the same night.

A baby, seven months old, had inhaled particles of wood into the larynx as suspended and the cords separated, no wood could be seen in right bronchus. Using an ordinary head mirror with 60 W. nitrogen lamp for illumination, forceps were passed down the trachea and large piece of wood removed. Several smaller pieces were seen on the tracheal wall and deep in the right bronchus. These on the table all were removed, the suction used that deep in the bronchus in the same manner but through bronchoscope.

These will serve to indicate that suspension has rather a special field of its own in foreign bodies in infants and young children and that it would precede the use of the tubes which again is in the natural order of application.

The selection and passage of the bronchoscope is the next step. One has his special likes in the matter of bronchoscopes, my preference being for the Killian baby set, which to me has these advantages. They are equipped with a hollow smooth mandrill, the blunt round surface of which will produce no traumatism at all. They give the largest working lumen and can be illuminated with a Brunnings handle, a Kersten lamp or as I frequently find useful with an ordinary head mirror with a strong nitrogen lamp.

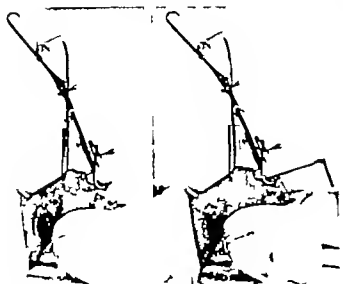


Fig. 1 (at left) New position for introducing the bronchoscope in infants and children.

Fig. 2 Introduction of bronchoscope under direct view protecting all parts from traumatism.

The tube should be well greased as should the larynx and cords. The cords are separated by my elevator or retractor and the tube passed into the trachea under direct vision without coming in contact with the subglottic space.

Once the tube has passed the vocal cords the mandarin is removed to establish respiration through the tube. Then we may proceed along two general plans. If it is probable that the tube will have to be removed and be reintroduced as in the case of multiple foreign bodies it is best to retain the patient in suspension. By guiding the bronchoscope through its lumen one will find that it is necessary to flex the head which can be done by the horizontal movement of the crane and the worm-gear joint. One is free to move the scope laterally because of the extra width of the pear-shaped ring. It might be said that the distal end of the tube may be raised or lowered by the vertical movement of the crane. It gives one the impression of adjusting a cannon for fire. One sights through the tube to the normal lumen and path of the bronchus and by moving the traveling crane in its various directions he so aims the tube as to permit its accurate passage through the bronchus.

It might be said that with the child firmly fixed upon the suspension apparatus it is much less likely to wriggle loose than when ordinarily held. One can handle the bronchoscope with much more delicacy by this means than ordinarily thus applies especially to the region of the stem bronchi.

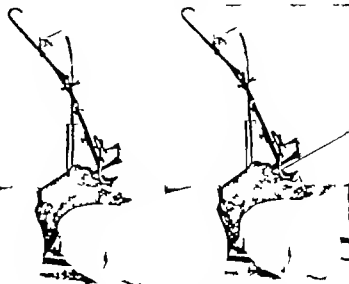


Fig. 3 Bronchoscope in right bronchus showing slight difference in plane of scope and instrument.

Fig. 4 Bronchoscope in right bronchus. Applicator in esophagus.

In one of my peanut cases portions of the hull of the peanut were also inspired and there were three pieces too large to come through the tube. With the suspension apparatus I had no hesitation in withdrawing the foreign body and tube because I felt no discomfort about the reintroduction. One does not relish the idea of reintroducing the tube in a baby eleven months old.

With suspension one feels a certain sense of security about respiratory disturbances. If the tube is withdrawn it can easily and quickly be reintroduced and if for any reason a tracheotomy should be necessary the patient is in the most ideal position for its quick performance.

If you prefer to use the tube unaided after its passage through the cords you proceed as follows: the baby tube with mandarin removed is resting in the trachea and respiration is quiet through the tube. The hook is removed from the crane and carefully tilted to the right to permit the removal of the left tooth plate. Then the right tooth plate is removed in the same manner. The pear-shaped ring is bent back upon its hinge and the screw holding the spatula is now loosened and the body of the hook is in this way disengaged from the spatula. Finally the spatula is removed. One then attaches his illuminating apparatus and proceeds with bronchoscopy as is usual.

The introduction of the esophagoscope is such a simple affair under suspension that it seems needless to describe it. The mouth of the esophagus is in most instances gaping and an esoph-



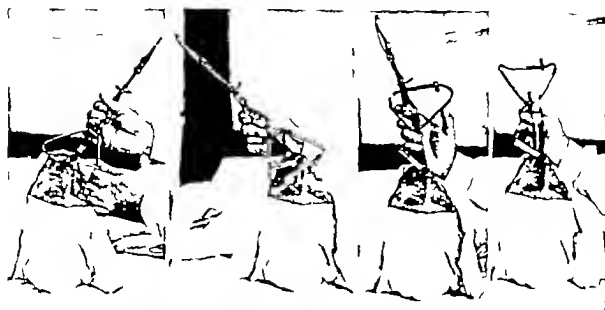


Fig. 5 (left) Diagram hook. Latter tilted to patient's right to remove left tooth plate.

Fig. 6 Hook tilted to left to remove right tooth plate.

Fig. 7 Elevation of ring out of eye of scope.

Fig. 8 Removal of spatula.

anoscope of suitable size will practically fall in. Its further passage through this canal is better managed in my opinion without the suspension apparatus, and the latter is dismantled as described above.

In the management of an impacted foreign body either in the larynx or in the mouth of the oesophagus, no instrument equals the suspension spatula. In the foreign bodies lying behind the cricoid, the cartilage may be lifted to a marked degree and space can be gained by hyperextension of the suspension spatula, that is by tilting the tip of the spatula by movement of the worm-gear joint and by horizontal movement of the frame. By use of either the speculum for separating the cords or an elevator one may lift the mucous membrane from an impacted point and with the other hand armed with forceps, remove, turn, twist, rotate, or fracture the offending mass and remove it without any damage whatever to the mucous membrane. Safety pins are turned the points are bent in and the body removed easily.

Teeth are cut from false teeth plates and removed and then the plates cut in two or sawed out without tearing the mucous membrane.

Lastly with suspension the surfaces can be treated after the removal of the offending body.

For instance in one of the watermelon-seed cases the body had produced considerable traumatism with the formation of plastic exudates in three locations. This exudate was removed, the surface was painted with tincture of benzoin, and vaseline applied to these areas as well as to the mucous membrane of the trachea. In one instance 25 per cent nitrate of silver was applied to a traumatized spot.

I call your attention to the fact that with the aid of suspension one is not only able to remove foreign bodies more easily and with less traumatism but he is permitted to treat what traumatized surfaces occur and practically bandage the wound thereafter just as our colleagues splint fractures, plaster joints and protect abdominal incisions with gauze and adhesive.

# RADICAL TREATMENT OF INTESTINAL OBSTRUCTION AND GANGRENE OF THE INTESTINE<sup>1</sup>

EFFECT OF WHIPPLE'S WORK ON INTESTINAL DRAINAGE METHODS OF MAYO ROBSON MOYNIHAN  
WITZEL VON MIKULICZ, AND MAYDL REPORT OF TWO CASES

BY HARLAN SHOEMAKER A.B. M.D. LOS ANGELES

THE subject and method of treatment of strangulation of the intestine is open to much speculation. Every physician can cite numerous instances in which expectant treatment has cleared up the case. Occasionally this method of procedure proves a failure and the attending physician finds valuable days have slipped away, his patient is steadily growing worse, fecal vomiting has begun, but otherwise his patient has that appearance of well being that belies the condition of the intestines which is eventually found at operation.

It is of these late cases with obstruction high up in the gastro-intestinal tract and the beginning of fecal vomiting that I wish to speak.

In reporting the histories of two patients who recovered after I performed a radical operation for gangrene of the intestines I also wish to call your attention to some new and old methods and make some reference to the bearing of Whipple's work,<sup>2</sup> upon certain modifications in the operative technique in this class of cases.

Obstructions high in the gastro-intestinal tract accompanied by fecal vomiting and gangrene of the intestines generally terminate fatally. Any method designed to save even a few of these cases may well merit some discussion.

**CASE 1: Von Mikulicz operation.** Case history No. 91104 County Hospital. Mr. H. W. entered the hospital February 8, 1916 by ambulance. The patient's symptoms began five days before with vomiting and abdominal pain following an attack of la grippe. The lower bowel was emptied by enema but the gas in the small intestine failed to pass. The abdomen was distended and tympanitic. At the outer border of the left rectus and about opposite the umbilicus, a short wide scar was observed. It proved to be the site of a previous abdominal incision through which about 9 inches of intestine was resected. The patient was shot through the abdomen eighteen years before during a charge against the natives in the Philippine Islands. After lying on the battle field three days, he was carried to the hospital, the intestine resected and united by a Murphy button.

Operation, von Mikulicz. I opened the abdomen at the site of the old scar and within its inner border. Entrance to the abdomen was gained at the upper angle of the old incision. A small loop of jejunum was found attached to the old scar. The intestine above the adhesion was bluish distended, and full of fluid, while

below the obstruction the gut was contracted and empty. At the point of obstruction a gangrenous band encircled the intestine and involved the mesentery. At first a lateral anastomosis was made isolating the loop after a method described by Mayo Robson. Slight pressure was used on the distended intestine to see if the fluid would fill the spastic gut. Nothing passed from the distended and paralyzed loop to the contracted and spastic loop. In fact all the stitching at one angle of the incision gave way.

Sewing a thickened contracted intestine to a distended and stretched-out one is poor mechanics even when the diseased part is not in the first state of dissolution. The Mayo Robson method has three disadvantages: (1) failure of fluid to flow into spastic gut, (2) failure of stitching to hold in friable intestinal coat, (3) poor mechanics in sewing a thick contracted gut to a dilated and paralyzed gut, any one of which would be the foundation of fatal termination. This method was accordingly abandoned.

The damaged intestine was pulled out of the abdomen, the incision closed down to the intestinal loop. The loop including all intestine suspicious of gangrene was removed and the ends held in the wound by silk-worm-gut sutures. A straight clamp held the intestine aside to slide. It was necessary to tie the clamp down into the abdomen as the pressure from within tended to force the instrument above the peritoneum. The best result with the von Mikulicz operation is gained when the spur is broken off well below the peritoneum. Two rubber tubes were placed one in each end of the intestine, the proximal one for drainage, the distal one for the purpose of aiding the water intake and possibly for nourishment.

The upper portion of the intestine emptied itself promptly enough. The abdomen became scaphoid and remained so. The tube in its lumen was as useless as the one in the distal portion of the intestine. It was impossible to make the lower bowel take oil, and the spastic condition did not change immediately. It was twenty days before anything trickled through sufficiently to promote a bowel movement. At this time the lower bowel would retain any quantity of olive oil and a bowel movement could be had at will.

The jejunostomy was near the stomach. The gastric juice poured out of the proximal end of the divided intestine in highly acid condition. The outer wall of the abdominal incision was digested down to the peritoneum in an area at least 3 inches square.

The acid discharge from the fistula showed a total acidity of 12. There was no free hydrochloric acid. Liquids and undigested food passed through the fistula 10 to 20 minutes after ingestion—the time varying with the amount of liquid.

The patient's water absorption was aided by the Murphy drip method. A mild nephritis developed

<sup>1</sup> Intestinal obstruction, protean intoxication. J. Am. M. Ass. 9, Aug. 6.

about the third week postoperative. Otherwise the recovery was uneventful and the patient was discharged cured, with a fistula April 20, 1906. On June 3, 1906, I resected the fistula and made an end-to-end anastomosis. Fortunately the repair of the intestine removed all the adhesions of the adjacent coils. Recovery was uneventful.

**Case History No. 987.** County Hospital. Mrs. I. G. entered the hospital February 20, 1906, by ambulance. The present condition began a day before with acute abdominal pain referred to the region of the appendix. She had been unable to have satisfactory bowel movement, although drastic enemata had evacuated the lower bowel. Chills had followed onset. During the past twenty-four hours fecal vomiting had been increasing in frequency.

On examination of the patient her general condition was good. A leucocytosis of 10,000 and slight rise of body temperature (99.1) existed. There was the patient presented no unusual features. Inspection of the abdomen revealed a scar in the midline below the umbilicus, three and a half inches long, freely movable on the underlying tissues. This scar, the site of the appendectomy, was scars previous. The abdomen was not distended nor was there any great tenderness on gentle palpation. There was no abdominal rigidity.

On April 10 modified McMillan. The abdomen was opened at the site of the old scar, entrance to the abdominal cavity being obtained above the upper angle of the old incision. It tended and gangrenous intestine presented itself in the wound. Beneath dense adhesions, the distal contracted and empty intestine, as picked up six feet of the damaged jejunum was resected. The distal end of the intestine was placed on the side of the proximal end by a Murphy button and the proximal end was brought through a stab wound at the site of McBurney's point. A rubber tie was tied to the lumen of the gut and carried over the side of the bed to a bottle. Within a few days the strong fecal odor disappeared from the discharge. Subsequent treatment resolved itself into a number of problems for example when to close the fistula when the Murphy button be passed, when will the bowels resume their normal function.

The recovery from such an extensive resection, as very satisfactory. The patient did not vomit and suffered no gas distention.

On the sixth day postoperative the intestine projecting beyond the skin and tied to the drainage tube separated from the body much after the manner of the separation of the umbilical cord. Consequently the rubber drainage tube, thus the lumen of the gut failed to drain and finally slipped out altogether. The acid jejunal contents now spilled over the abdomen. At the same time the original incision had healed and what stitches remained were protected from the intestinal discharges. At this time the second step of this rather complicated procedure should have been taken, namely the closing of the fistula. While debating the various means of closing the fistula, the patient became so exasperated from intestinal discharges that the next few weeks were spent in trying to heal the skin and make the patient comfortable enough to sleep. The normal bowel movements occurred intermittently after the sixth day. Olive oil introduced into the fistula from time to time facilitated things very much. Petroleum by mouth reduced the irritability of the intestines above the fistula and ameliorated the burn on the skin.

After the fourteenth day the skin irritability became worse. The Murphy button had not passed. A instrument introduced into the lumen of the bowel detected the button in the blind end of the gut.

Undoubtedly the fistula would have been closed sooner had I known how easy it could be under nitrous oxide

anesthesia. To close the fistula the protruding end of the jejunum was pulled through the abdominal wall, crushed, cauterized and inserted as the appendicostomy stamp is treated, then allowed to drop back into the belly cavity. A retaining suture held the now blind end of the gut to the peritoneum as matter of precaution.

The intestine, after closure leaked gas and feces through the fistula at least on three separate occasions. However the gas was partially held in the intestinal canal. The intestine turned distended the abdomen high bluish to was markedly scaphoid. Ten days later the Murphy button passed and the patient left the hospital well later May 2, 1906.

This brief description of the two cases offers several things in common. Both were obstructed high up in the gastro-intestinal tract both were postoperative cases. On the other hand, one the more extensively involved of the two was a so-called clean case which became obstructed six years postoperative while the patient who received the greatest peritoneal trauma went eighteen years. One was an emergency operation the other an elective operation originally. Both patients had had fecal vomiting prior to operation. Both had a slight leucocytosis. Neither patient exhibited any reaction of pulse, temperature or respiration.

The pathology in both cases was similar and only varied in the amount of intestine involved. The intestine was distended with fluid and gas above the obstructing bands, and completely collapsed below them. An area of gangrene existed at the site of primary obstruction.

Whipple in a recent article maintains that the lethal factor in intestinal obstruction is a poison within the intestinal tube. This poison a primary protease is soluble and not altered by bacterial action heat or acid, and when re-absorbed which according to Whipple occurs in cases of distention and paralysis of the intestine kills the patient.

Sir Berkley Moynihan in his monograph on "Abdominal Operations" illustrates a tube for the removal of the intestinal contents above the obstruction. He states that if this is not done the patient will succumb. The danger of soiling the abdominal cavity by removing putrifying intestinal contents with the abdomen open is very great. With a drainage two-stage operation this danger is more remote.

The several methods of treating gangrene of the intestine which have been in practice since 1850 are as follows:

Mayo Robson a method may be described as a lateral anastomosis of a single loop of bowel with a tube drain at the convexity of the loop. The operation is adapted to jejunostomy where there is no necessity for removing damaged gut. As I

have suggested sutures hold very poorly in distended and paralyzed intestine which is one factor to be considered in this operation.

The necessity of an extensive resection eliminates the use of the Mayo Robson method.

Moynihan describes his modification of Witzel's method which is done by imbedding a rubber tube in the long axis of the bowel. The peritoneum is cast over the tube which in turn is brought out of the abdominal wall. The author has previously syphoned or milked, all the contents of the distended and paralyzed gut out through a large metal tube passed into the lumen of the gut. Any one of the following factors make this method of Moynihan unsafe in operations for gangrene of the intestines. First the diseased intestine is not removed. Second, simultaneous drainage and handling of the intestines will of a certainty soil the abdominal cavity and possibly be followed by peritonitis. And finally a tube small enough to be sewed into the intestine as suggested by Moynihan may not drain the diseased intestine sufficiently to do any good, or the site of drainage may be the seat of future obstruction.

Von Mikulicz described a method of forming a colostomy with both ends of the colon projecting from the wound. The colon is sutured side to side. Some time subsequent to the first operation, a clamp is introduced one blade in the lumen of each gut and the clamp closed. Autolysis takes place within the bite of the clamp the spur between the two ends of intestine is cut through. The fecal stream follows this new avenue and the fistula closes by granulation.

The von Mikulicz operation was adapted by me to the first case reported with this slight modification. I applied an operative technique designed for the colon to the jejunum and I also made use of the clamp at the time of the original operation. Using the clamp between the two portions of intestine at once obviates the necessity of extensive lateral suturing and also the possibility of involving in the bite of the clamp an adjacent coil of intestine when inserted subsequently to the original operation. Soiling of the operative field is easily prevented by the use of soft pressure clamps higher up on the bowel.

The chief objections to the von Mikulicz operation are the soiling and digestion of the wound postoperative and the excoriation of the skin may be so extensive as to prevent recovery through loss of sleep and general irritability on the part of the patient.

The long period of granulation necessary to heal the fistula coupled with a partial or complete

loss of *succus entericus* over a similar length of time produces marked irritability in the patient. When the greater percentage of intestinal contents pass through the bowel the change in disposition in the patient from excessive irritability to a state of geniality is very remarkable.

The operation in the second case was designed to obviate certain disagreeable features of the von Mikulicz method long-continued drainage excoriation of the skin and loss of surgical control over the closing of the fistula.

#### METHOD

After all gangrenous and obstructed intestine has been resected an end-to-side anastomosis of the distal fragment is made about six inches from the end of the proximal fragment. The proximal fragment is drawn through a stab wound in the abdominal wall as far away from the original incision as possible. A drainage tube  $\frac{3}{8}$  inch in diameter is tied in the gut and carried over the bed into a bottle. The original incision is closed. Faecal contamination of the skin will not begin until about the sixth day when the portion of intestine tied to the tube above the skin will separate at a level of the skin at the stab wound. Feces will now flow around the tube. At this time under nitrous oxide anesthesia the bowel should be drawn farther through the stab wound crushed tied cauterized and the stump invaginated similar to the method used in treating the appendix. The stump will now slip back into the abdominal cavity of its own accord. It is safe to tie the stump to the peritoneum with a single stitch. If leakage occurs it will have easy egress.

The Murphy button is used because it insures a patulous anastomosis.

The operation described was original with me at the time it was done. However I have since discovered that Maydl described a jejunostomy somewhat similar to mine in 1891.

This method is impossible in gangrene of the intestines as the proximal fragment is too much distended to draw into the grasp of a Murphy button and too fragile to hold stitches. Further more drainage of the upper intestine would be imperfect even if it were possible to unite a distended paralyzed gut into the side of a contracted and spastic one.

#### CONCLUSIONS

- 1 Remove all the intestine involved by extensive resection.
- 2 Drain the distended gut by a fistula.
- 3 Close the fistula as soon as possible after the drainage has lost its fecal odor.

# TRANSACTIONS OF SOCIETIES

## CHICAGO GYNECOLOGICAL SOCIETY

REGULAR MEETING HELD JANUARY 19 1917 WITH THE PRESIDENT DR CHIANGINO  
W. BARRETT IN THE CHAIR

### INTESTINAL OBSTRUCTION FOLLOWING A GILLIAM OPERATION

DR THOMAS J. WATKINS: I desire to place on record a case in which the Gilliam operation was followed by intestinal obstruction. The operation had been done some time before obstruction occurred. The cause of the obstruction was an opening that was left between the internal ring and a loop of the ligament brought out through a stab wound in the abdomen. This opening was not larger than the circumference of a moderate sized finger and yet about 10 inches of the small intestine herniated through it. It became twisted 180° became necrotic and necessitated resection.

This case is important because it illustrates the danger of leaving such an opening with the Gilliam operation. I believe it can be safely stated that nearly all operations upon the round ligaments that are done with puncture through the abdominal wall leave an opening between the internal ring and the loop of the round ligament. I have seen very few Gilliam operations performed omitting that opening.

Dr Simpson some ten years ago called attention to this danger and modified the Gilliam operation by puncture through the internal ring and in that way found no opening through which the intestine could herniate.

I have been also much impressed with the fact that there is too much traumatism in operations on the round ligaments by puncture of the abdominal wall. We can do just as much shortening as we want inside of the abdomen and do it just as securely if done carefully with a good deal less traumatism. The old argument that there is a difference in the strength of the ligament in different places seems to be more theoretical than practical.

DR. EUGENE CARY: Inasmuch as the round ligament operation has been brought up I would like to say a few words, concerning the operation that has been done by Dr Webster. When I was an interne I saw quite a number of round ligament operations done and I think I may say they were done safely and properly. I have since seen what is termed the Webster round ligament operation done again and while the round ligament was used, there was no real comparison between the two operations. When a great many operators report failures in the work done on the round ligament by that

method it is because they do not adhere to the proper technique.

It is important in following the Webster-Baldy technique to bring the ligaments first through the bloodless area and second to fasten them to the posterior wall of the uterus with non-absorbable suture material, such as linen or silk and anchor them in such a way that the circulation of the ligament itself is not cut off. These are the essentials to the success of the Webster round-ligament operation.

### MARKED PLACENTAL INFARCTION

DR WILLIAM C. DANFORTH: I want to show a specimen removed from a young woman 35 years of age. Her first pregnancy and labor so far as I know were perfectly normal. She does not believe at that time that any albuminuria was found and her blood-pressure was not taken by the physician who had her in charge. However she gave birth to a perfectly normal child at term, which is still living and well.

She first came under my care August 10. Until November 31 her course was uneventful at which time her blood pressure went up to 145 and then to 160 with marked albuminuria. She was then at the hospital and kept under observation for ten days. The albuminuria decreased markedly and her blood-pressure came down to 130 under restricted diet and rest in bed. She was under the care of a trained nurse her blood pressure was taken daily the albuminuria disappeared, and her blood pressure remained in the neighborhood of 130 for two or three weeks, after which albuminuria occurred and remained until delivery. She went into labor four days ago being at term January 30 and was delivered of a two pound and 14-ounce baby. The placenta is the principal thing I want to show tonight. The baby was perfectly formed. The pediatrician who took it in charge said that there were found slight evidences of scaling but there was nothing syphilitic. It shows the tremendous area of infarctions, but about one-third of the placenta is active, and the remainder a large mass of infarctions, there being a sulcus where the scarred area is completely separated from the live area. The entire mass at this site showed normal placental tissue.

This is my first experience with such a case. I have seen a number of infarcted placentas more than ordinarily with albuminuria, but never had one where the great majority of the placenta was put completely out of function with the patient going on so nearly to term. The small weight of the baby was due to the deficient blood-supply. The uterus at the time of delivery reached about to the umbilicus where it remained for months without any evidence of growth. The child was delivered alive but there was some trouble in getting it to breathe. It did very well for the first twelve hours but died in eighteen hours.

DR. CULBERTSON. Did she have toxæmia or albuminuria?

DR. DANFORTH. She had a blood pressure running up to 160 with some headache a little epigastric pain at one time but she did have hypertension which lasted for days, but which decreased under rest in bed and a limited diet but recurred again. I induced labor in spite of the smallness of the child *in utero* at the time she went into labor.

DR. CULBERTSON. There was no edema?

DR. DANFORTH. No.

DR. CAREY CULBERTSON. I think this case of Dr. Danforth's is interesting and suggests a point brought out in 1914 by James Young of London in an article which appeared in the *Transactions of the British Royal Society of Medicine*. This was illustrated with a few plates in color showing placental infarction. The point made by Young was that infarction is even more frequent than supposed and in every case of toxæmia one would find it. He seems to think that the source of poisoning in toxæmia of pregnancy is due to placental infarction. There was a series of cases reported every effort being made to bear out that contention that the toxæmia was associated with or due to placental infarction. In his cases of toxæmia, where the placenta was examined carefully infarcts could be found. These infarcts did not always appear on either the placental or fetal surface but often in the center of a cotyledon so that the placenta would have to be sliced in order to find the infarct.

DR. CHARLES E. PADDOCK. Recently I attended a case of labor which presented an unusual feature and was of great interest to me. I presume some of you have seen similar cases but this was my first experience. A primipara with normal pelvis and head engaged went into labor at term. After three hours of characteristic first stage labor pains the membranes ruptured and soon the patient commenced to have hard frequent bearing down second stage pains. A rectal examination showed the head well down in the pelvis practically upon the perineum and occiput rotated anteriorly. No cervix evident and probably external os fully dilated.

After 4 hours of second stage labor pains and no progress a vaginal examination was made which seemed to confirm the rectal examination. However upon passing the finger high round the head it showed that the cervical portion was between the

finger and the head and as thin as paper. The external os could not be found, the cervix being like a thin membrane over the head. With this tissue in view a search was made for the external os which with the greatest difficulty was found although its location was immediately in view. After several failures to locate it a small probe passed between this membrane and the head with this probe the os was dilated without any trouble to admit a finger and in less time than it takes to tell it the os dilated several centimeters. The case was now left to nature to deliver normally.

I am at a loss to account for the condition. There was no spasm of the cervix in fact it was just to the contrary. What would have soon happened had the condition not been corrected would have been a complete amputation of the cervix—cases of amputation of the cervix having been reported. The necessity of vaginal examination must not be overlooked, although rectal examination in labor has limited this necessity.

#### RUPTURE OF THE UTERUS FOLLOWING THE USE OF PITUITRIN

DR. WALLACE F. GROSVENOR. I would like to mention a case I saw two weeks ago with another physician. Rupture of the uterus followed the use of pituitrin the case being one of occipitoposterior position with the head firmly entered in the foramen but not descended to the second stage. The nurse was called at 2 o'clock the doctor got there at 5 and at 6 o'clock, with a moderately well dilated cervix but not a retracted cervix four drops of pituitrin were given hypodermically. At 6:35 the head not having descended through the brim the doctor was getting ready to apply forceps and from five and one-half drops of pituitrin were given at about 6:35. I might say the woman was a primipara healthy and 20 years of age. In the second pain, after the second hypodermic of pituitrin the woman went into collapse and the doctor asked me to come right over. There was a rupture of the uterus the child's body was perfectly mobile in the abdomen and the patient was in collapse. With the consent of the priest we opened the abdomen drew out the child and brought the uterus forward, and put a catheter around it but the baby was dead and the mother died within two or three minutes more. The rupture of the uterus extended from the top of the fundus on the left side just posterior to the utero-ovarian ligament went clear down the uterus through the cervix into the vagina and up the left broad ligament to the brim of the pelvis.

DR. W. A. NEWMAN DORLAND. In connection with this case I recall that there was recently reported an abstract of a paper from Buenos Aires in which the author describes five or six cases of rupture of the uterus following the use of pituitrin in the hands of midwives. It is interesting as showing the possible danger of the use of this drug where there is obstruction or imperfect dilatation.

## FULL TERM ABDOMINAL PREGNANCY

Dr. EMIL G. BECK (by invitation) read a paper entitled Full Term Abdominal Pregnancy. A Normal Labor Intervening Between Gestation and Operation. Specimen and Patient.

## DESICCATED PLACENTA IN OBSTETRICS WITH SPECIAL REFERENCE TO VOMITING

Dr. EUGENE CARY (by invitation) read a paper entitled Preliminary Report of the Use of Desiccated Placenta in Obstetrics with special Reference to the Vomiting of Pregnancy (see p. 206).

## DISCUSSION

Dr. CAREY CULBERTSON At this time considering the immense amount of study that has been given to the internal secretions it is almost impossible to discuss pregnancy and toxemia apart from a consideration also of the internal secretions and their disarrangement.

As far as toxemia, or the nausea and vomiting of pregnancy go there is nothing in the literature that is at all definite. There are however certain fairly well formulated ideas that may be expressed with respect to the use of placental extract. We know that as far as cellular activity goes the placenta is only active during the stage of trophoblastic development. If we have any hormone secretion formed in the placental tissue it would seem to be in the stage of trophoblastic activity. If the trophoblastic stage has passed into one of degeneration we have no structure in the placenta capable of giving out any material that would have a specific action. If the placental extract is going to be used it should be of early placenta, or early chorionic fluid before the placenta is formed as an organ. In woman this would be before the end of the fourth month. It seems to me here is where this method of trying placental extract and treating various conditions pertaining to pregnancy fails not only in lactation but in nausea and vomiting.

I received some of this placental material from Parke Davis & Company sometime ago with the idea of feeding it to patients to increase lactation and found it absolutely disappointing. I did not have a single case where I thought the lactation was benefited in any way. I first made effort to ascertain the time of pregnancy when placenta were taken from which to make this desiccated extract. After some delay I ascertained that they took the placenta throughout the various stages of pregnancy, some from very early pregnancies and some from full-term pregnancies, which is enough to show why this material would be inactive at certain times, and relatively inactive at all times.

So far as the treatment of the nausea and vomiting of pregnancy goes we have the report of a very interesting series of cases given in a recent issue of the *Journal of the American Medical Association*. In this article the author Hirst reports 36 cases

32 of which the results were favorable treated by intramuscular injections of the liquid corpus luteum. Hirst bases his treatment on the theory that, the only being inactive during early pregnancy there is a relative ovarian deficiency and corpus luteum will make up for this. I have used this preparation now in five cases of the ordinary nausea and vomiting of pregnancy but not in toxemia, with favorable results. It should be stated that I kept the patients under the usual dietary treatment as well as the same time.

There is another thing that is of importance in this discussion and must not be lost sight of. Hermann, Halban and other investigators have shown experimentally that the physiologic action of the trophoblast is identical with that of the corpus luteum of pregnancy. If this is true and if corpus luteum of pregnancy is effective then the extract of a fresh corpus luteum should give the same results, or even better than corpus luteum itself because there is more of it and it is possible to make a stronger preparation. It seems to me, that this is just about where we stand in this matter regarding the production of an internal secretion from placenta. It is unfortunate as has been pointed out long ago that hormones do not produce antibodies and cannot be proved by any complement fixation tests. That is the reason why the whole matter is so difficult to work out. Another fact is that the other glands of internal secretion also are all modified in pregnancy in some degree.

Dr. CARY (closing) There are only one or two points I would like to mention in closing and one is that naturally the results that Dr. Culbertson report would necessarily be being taken in the demonstration of placental extract because, we may until the dosage is established have to confine ourselves within a safe limit so I have made it a point to administer recently the extract in five grain doses by mouth 3 times daily for a matter of two or three days. At this time the administration was stopped because I have clinically proven that a dose of this size given for this length of time has no bad effects in the fetus. I expected some one would take exception to the administration as given by the mouth, and as having no effect as with thyroid extract given by mouth. The placenta contains amino-acids which are absorbed from the intestines unchanged.

## FETAL MATURITY IN UTERO

Dr. CHARLES B. REED read a paper entitled A Study of Fetal Maturity in Utero (see p. 201).

## DISCUSSION

Dr. C. G. GRULEE The thing that occurred to me during the reading of Dr. Reed's paper was, What definite knowledge have we that a child is mature? How do we know that a child is mature? I know we have various ideas on the subject, such as measurements, and so forth, but these measurements have been taken on children who were born

under natural conditions and if we consider that a certain number of these cases have remained *in utero* two or three weeks longer than the time of supposed maturity then we certainly do away with the strength of any conclusions we may draw as to what definite maturity means.

I have been struck with one fact during the last two years. I have been rather regular in my attendance on the new born infants in the Maternity Ward of the Presbyterian Hospital, and I have been much surprised to find what a large percentage of babies will show a wide open sagittal suture. The sagittal suture itself does not seem to depend upon the maturity or prematurity of the infant. Again we will have infants apparently born at term where the sagittal suture will be quite soft. It seems to me the crux of the whole situation lies in what we mean by maturity and whether we have definite means of determining such a maturity.

DR. RUDOLPH W. HOLMES. If Dr. Reed had discussed in his paper these various methods of determining the size of the baby, I would be tempted strongly to corroborate what he had to say, but when he points out these various methods of determining maturity or immaturity of the baby, I think he is wise of the mark. I think Perry depended upon the size of the baby in relation to the pelvis and the adaptability of the fetal head to the pelvis. Ahfeld had the same thing in mind, but when it comes to say a certain length means maturity or immaturity, we know there is a variation. A baby may be fully mature and yet there are normal variations in length and weight and in the lustiness and general vigor of the body. I have used the Perry method for years. I think it is of some relative value not only in determining the size of the baby but its maturity. When you can palpate and map out the size of the pelvis, Perry's method is a valuable adjunct in determining the adaptability of that head to the pelvis. We have to concede that 14 and even 18 pound babies do exist at term, though I have never seen one that weighed more than 13 pounds and a half. It is not in the last days that the baby waxes strong and becomes large. It is a gradual progression from the beginning of pregnancy to the end, therefore a baby which is going to weigh 12 or 14 pounds at 7 months will be larger than the ordinary baby at full term. Therefore McDonald, Perry and Ahfeld give us erroneous deductions.

DR. CHARLES S. BACON. In the consideration of this subject I think it is well to call attention to some other factors besides the length of gestation that influence the size of the child, the length of the child, and the size of the fetal head. One cannot say just what is the normal duration of pregnancy in any particular woman. When a woman has a period of gestation less than 280 days in one or more pregnancies she is apt to have the same period in subsequent pregnancies. If a woman is delivered in 268 days in one or two pregnancies I take that into consideration in estimating the date

of labor. The usual duration of gestation is an important element in determining the maturity of children.

I quite agree with what Drs. Holmes and Grulee have said that these various methods of determining the size of the fetal head and size of the child are important especially in cases of contracted pelvis but do they determine the maturity of the child?

In considering the obstetrical problem one method that Dr. Reed has not adopted in his studies of maturity is the impression of Moller which when carried out is rather more difficult than those he has mentioned but which is undeniably of a good deal of importance. The amount of moldability of the head which is due in part to the factor that Dr. Grulee has spoken of the size of the fontanelles and the distance between the bones and sutures is also an important factor in the labor. That is something that can be determined with great difficulty or perhaps not at all by any of these methods so that while these methods are desirable and these measurements should be made as a matter of routine in order to acquire the technique in determining the accuracy of the measurements yet I do not believe they are of very great value in the problem which has been put before us tonight. When we take the figures which come from the Munch clinic, where the weight of the baby is taken as the chief index we find that 7 per cent perhaps of all the children are larger than the limiting weight of 4000 grams. A study of those cases shows definitely that in the average pelvis at least the size has not any particular bearing upon the obstetrical problem. Almost all of the labors terminated spontaneously.

The mortality of the children was rather below than above the mortality of children generally. The size of the child had very little bearing upon the general obstetrical problem, and the Munich figures would contradict the statement of Dr. Reed that a child of 10 pounds is a disgrace to the obstetrician.

DR. N. SPROAT HEANEY. The discussion so far has dealt with the point as to whether it can ever be said that a patient is due or not since we cannot estimate the date of conception. While this is theoretically true, there is no one here present tonight who hesitates, while making rounds in a Maternity in pointing out certain babies as mature or premature after they have been born using largely size and weight to help him in his estimation. I am therefore surprised at the modesty of those who profess not to be able to tell with reasonable certainty before labor begins.

If Dr. Reed had not designated his procedures a means of estimation of maturity but instead had said means of estimation of the size of the child I think that no one here could help but concede that his work is of great value and after all when one estimates size and weight he is estimating maturity by the best means that we have at our disposal.

My experience has not been so great as that of



Dr. Reed: As I have not checked over my measurements during pregnancy with those of the child after delivery but I have always felt that the measurements mentioned by him are of the greatest importance. I was surprised, however, to find with what accuracy his estimation and the actual size of the fetus agree, especially in reference to the precision of measuring the fronto-occipital diameter since the measurement before labor is of an unmolded skull while the measurements after labor are from the head which has undergone molding and especially a shortening of the fronto-occipital diameter. If there were a constant ratio existing between the measurements taken before and after labor I would not be surprised but to find that they are the same in such a high percentage of cases certainly requires explanation not only because of the molding, but because of the impossibility to always accurately locate the fronto-occipital diameter. I wish Dr. Reed might tell us concerning this particular estimation. I consider myself indebted to Dr. Reed for the laborious work which he has performed in order to give us this accurate comparison between the measurements before and after labor. When these measurements can be so accurately estimated that we can tell the approximate length of the child as well as the diameters of the skull there is little chance of inducing labor and securing a premature child if these measurements are made beforehand. Since we are looking for a safe basis the value of this work cannot be overestimated therefore it seems foolish to lose sight of the particular merit of this work in a discussion of theoretical conditions that prevent one from saying that any child unborn or born is definitely mature.

Dr. Reed (closing): I am much gratified at the discussion that has been brought out by this little work of mine which though tentative is a serious effort to find out exactly what is going on in the uterus as far as we may in the course of the last weeks of gestation.

As to what constitutes maturity of course we are in doubt. I think we can safely say that a mature child should possess those qualities of growth, development and vigor which would enable it to live easily after birth. We could not express it any more closely than that. But what does maturity mean anyhow. Can we state decisively what

those conditions are that determine maturity either in the uterus or after puberty? I think one is as safe and as certain as the other.

Dr. Bacon referred to the normal duration of labor. That too, is a question which is moot. Without urging it as a scientific argument at all, I may say that Christ—who was the most perfect man that ever lived probably—we may assume it at any rate—was born 275 days from the date of the Annunciation. I do not regard that as scientific, but I bring it forward as an interesting corollary to the conditions. Dr. Bacon has specifically defined prematurity in a recent publication and to do that one must have at least a vague comprehension of what constitutes maturity and therefore an idea as to the normal duration of pregnancy within certain limits.

As to the use of the Mueller method, we have used it very frequently where the pelvis is contracted, and that particular method is valuable in determining whether the head will fit a particular pelvis, but it has no reference whatever to the problem which we are trying to solve by making these measurements upon the head and body of the child *in utero*.

Dr. Heaney's remarks about the molding of the head were very pertinent and I will say it caused us a great deal of concern to know how that problem would work out. We made a number of experiments upon the head after molding had apparently disappeared but strangely enough we found no variation in the biparietal diameter. We found the biparietal diameter did not vary from the measurements made immediately after labor. This was an interesting fact in connection with our work because it would seem as Dr. Heaney remarked, as if the molding of the head as it is forcibly driven through the pelvis must of necessity produce some changes in the biparietal diameter which we could not estimate and that they would be restored at a subsequent date but it is not so the conditions are as he stated them.

The work has been extremely enlightening to me. I do not expect that there are many who would care to take the time and trouble to carry out such refinement of technique nor would they be especially concerned to ascertain how large the child is, or whether it is of any size at all. But to those who are interested in the scientific pursuit of obstetrics the problem has a definite fascination.

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## SYMPOSIUM ON THE RELATION OF THE GLANDS OF INTERNAL SECRETION TO GYNECOLOGY AND OBSTETRICS<sup>1</sup>

### INTRODUCTION

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THIS introduction is written with the aim of bridging some of the gaps which of necessity occur in a symposium prepared by several independent investigators who are obliged to confine their remarks to particular and limited fields. A cursory survey of the entire subject may therefore serve a useful purpose.

When the study of the glands of internal secretion was in its infancy only arresting and striking facts such as the amenorrhea and ablation symptoms following castration or gross abnormalities which could not be overlooked such as premature sexual ripening attracted the attention of the gynecologist and obstetrician. Today on the contrary many minor changes in the appearance behavior or physique of the patient are ascribed to the endocrine organs. If anything this tendency at once to apply clinically the knowledge obtained by degrees at the bedside the postmortem table and in the laboratory threatens to mislead and to bring discredit upon an important branch of medical science.

In every department of knowledge it is expedient, at intervals to stop examine and meditate to take stock so to speak, of

closed open, and future prospects. Let this be such an occasion.

Femaleness is an attribute of woman possessed in varying degree by individual members of the sex, primarily designed to foster the continuation of the race. Just as determination of sex is decided in the ovum perhaps even before fertilization takes place, so the future fertility or sterility of the individual is often determined during infancy or before puberty.<sup>2</sup>

In order to comprehend the problems which confront us it is necessary to trace the influence of the glands of internal secretion from the time of conception and follow it through senescence. A thorough study of this sequence is still frustrated by the incompleteness of our knowledge.

### INFLUENCE OF THE GLANDS OF INTERNAL SECRETION NORMAL EFFECTS

*In utero* That the maternal sex glands or gonads are not indispensable to the fetus after the fertilized ovum is firmly fixed in the

The degree of femaleness of feminine attributes, can be influenced by experimental methods. Stebbins has made male guinea pigs feminine by castration, breast development, etc. by implanting ovarian tissue. Klotz has made doves either overfeminine or overmasculine in their behavior and characteristics by injecting oestrogenic ovarian or testicular material. The possible bearing of these experiments on the subject of homosexual and heterosexuality is self-evident.

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uterus has been repeatedly proved by the birth of perfect children born of mothers castrated early in pregnancy (Essen Moeller Orgler etc.) That the influence of some of the maternal glands is not entirely negligible is shown by abnormalities sometimes noted in children born of mothers with diabetes hyperthyroidism and tetany. This apparent variability may perhaps be accounted for by the fact that at least some of the glands of internal secretion probably began to functionate early in fetal life. Among those investigated are the pancreas (Carlson) adrenal (Hoskins, Fenger) and thyroid (Halssted). The possibility of determining the influence of the gonad of the embryo has now been brought within measurable reach of experimental proof by Swift's observation that the germ cells of the chick at an early stage lie upon the yolk sac separated from the embryo and may be removed without necessarily killing the embryo (Swift, Reagan). Our knowledge of this subject is as yet quite incomplete.

*Postpartum.* Immediately after birth the sex organs and breasts of both male and female children are larger and may show a degree of stimulation (uterine bleeding, colostrum) which disappears within two to three weeks postpartum. This hyperplasia has been ascribed by Halban to stimulating substances derived from the maternal placenta.

*Infancy and prepuberty.* During infancy, graafian follicles develop to a certain degree and then regress. The ovaries must exert some influence during this period because early castration in animals produces cunichoid types characterized by undeveloped sex organs and changes in the height, bony skeleton and in the glands of internal secretion. The opposite extreme is noted in those rare instances, in which premature sexual development occurs without gross lesions (Lenz). What influence is played by the so-called puberty glands (thymus and pineal) in favoring or inhibiting sexual maturity is uncertain.

The developmental period is of critical importance to the individual because anomalies directly ascribable to the stage of pubescence are noted with great frequency in

the mature individual. These variations from the normal may manifest themselves in apparently disconnected phenomena such as external appearance (height, facies, hair growth) in the internal economy (pelvic bones, genitals) in the degree of resistance to infection or disease, and in the soul life and intelligence. The exact mechanism by which normal development and variations from the normal are produced is far from clear. Much of the obscurity is due to the almost inextricable interaction of the various glands which so far in the main defies analysis.

*Sexual maturity.* In the human female the onset of maturity which is a gradual process, usually evidences itself by a series of related phenomena. Popularly the best known is the appearance of menstruation. This coincides with the full development of a graafian follicle and is followed by rupture of the follicle and consequent corpus luteum formation, a gland which, among other functions, regulates the periodicity of menstruation (L. Loeb). From then on during complete health unless disturbed by pregnancy cyclical changes occur in the ovary and uterus, and at least in certain individuals in the breast, until the onset of sexual senescence. Some evidence obtains that other glands of internal secretion in addition to the ovary participate in the cyclical changes to a varying degree. Among them are the adrenal and the thyroid.

The onset of maturity is also marked by the completion of development of the secondary sexual characters, some primarily designated as sex allures, others having direct bearing upon the procreative function. Among the female secondary sexual characters of the first class are fineness and distribution of the hair, development and distribution of subcutaneous fat, gracile larynx with high pitched voice and feminine psyche. Among those of the second class of chief importance is the development of the pelvis with large cavity and broad outlet.

The coincident involution of the thymus and pineal gland and the enlargement of the thyroid are not fully understood.

*Pregnancy* not only produces local changes in the sex organs (cessation of the cycle with

persistence of the corpus luteum growth of the uterus formation of the placenta hyperplasia of the breasts) but, likewise exerts a profound influence upon the entire organism. Of the glands of internal secretion the hypophysis undergoes the most manifest alteration (Erdheim and Stumme). Variations in function of the adrenal thyroid parathyroid and pancreas are not uncommon. Elaboration of this phase of the subject is not indicated in this connection.

*Sexual senescence (menopause).* This period apparently coincides with the permanent cessation of follicle ripening. The ovaries no longer functionate and consequently atrophy of the internal and external genitals and of the breasts supervenes. There may be changes in the alterable secondary sexual characteristics—fat and hair distribution psyche. Alterations in the other glands of internal secretion probably occur but are not well understood.

This cursory résumé attempts to give in broad outline the main phases which occur from the onset of foetal development to old age in the life history of the normal female. Keeping in mind this standard we will be in a better position to recognize variations from the normal.

#### INFLUENCE OF THE GLANDS OF INTERNAL SECRETION VARIATIONS FROM THE NORMAL

Before ascribing symptoms arising in the generative tract to disturbances of the internal secretions it is necessary to rule out other possible etiological factors. Only after such local or general causes have been excluded should the glands of internal secretion be considered. It is impossible to state whether other glands of internal secretion besides the ovaries can exert a *direct* influence upon the genital tract. This much however is clear that no matter what the origin of the stimulation or depression may be the symptoms produced are identical with symptoms arising from primary stimulation or depression of ovarian function. The functional manifestation whether of hyperfunctional or hypofunctional nature are often but not invariably dependent upon anatomical changes in the uterus vagina and external

genitals. No characteristic anatomical changes have as yet been detected in the ovaries. The anatomical changes and consequently the functional disturbances also may be transitory or permanent.

#### HYPOFUNCTION

Hypofunction may be primary or secondary. The foundation for *primary hypofunction* is often laid in the prepuberty period. Therefore (a) unalterable *developmental stigmata* may be noted—bone changes (long extremities short trunk, flat sacrum narrow pelvic outlet) as well as changes in (b) alterable *secondary sex characters*—hair and fat distribution (of eunuchoid or male type) (c) *Nervous symptoms* are frequent either general hyperexcitability or toridity and instability of the vasomotor system marked by sweats flushes and dizziness. (d) *Permanent local stigmata* may be summarized under the head of hypoplastic infantilitic genitals while the type of transient hypoplasia is illustrated by lactation atrophy. Symptomatically hypofunction is exemplified by sterility amenorrhœa, scant, irregular and painful menstruation.

*Secondary hypofunction* occurs most commonly in consequence of thyroid (exophthalmic goiter myxedema) hypophyseal (acromegaly dystrophia adiposogenitalis) adrenal medullary (Addison's) disease etc. Often after a transitory period of hyperfunction uterine atrophy sets in (amenorrhœa sterility).

#### HYPERFUNCTION

*Primary hyperfunction* with few exceptions is a disease limited to the period of sexual maturity. At the beginning (puberty) and end (preclimacteric) of this period hyperfunctional manifestations may be severe. The cardinal symptoms are menorrhagia and metrorrhagia. The uterine mucosa is often hyperplastic, and in many cases the uterine musculature is thickened (metritic type). Some evidence obtains that uterine fibromyomata are the result of functional hyperplasia.

*Secondary hyperfunction* is most often noted as a transitory phenomenon at the onset of some diseases of other glands of internal

secretion (exophthalmic goiter etc.) It may also result from local stimulation of the ovaries due to inflammation or tumors.

#### DIAGNOSIS

Routine diagnostic methods as practiced at the present day in the office dispensary and wards of the hospital will not advance our knowledge of the course of those diseases of the glands of internal secretion which produce gynecological and obstetrical symptoms. Not until thorough and complete studies, conducted by groups of workers, are begun and persevered with may we hope for concrete gain. The clinical material floods our institutions hidden under the guise of sterility, dysmenorrhea, neurasthenia, retroflexion, menorrhagia, metrorrhagia etc., unclassified, unstudied, unrelieved. Pathologist, pharmacologist and biological chemist must be enlisted in this work to co-operate with the clinician. Then and then only may tangible results be expected. No advance in diagnosis can be recorded since the writer presented the subject before the members of the Society in May, 1914.

#### ORGANOTHERAPY

Little if any advance in this branch of medicine is to be recorded in the last years.

Kendall has announced the discovery in crystalline form of the active principle of the thyroid gland. The method of preparation of this product has not yet been published in detail nor have the reports on its physiological activity been conclusive. Therefore this discovery which, if confirmed, will prove of the utmost importance is still *sub judice*.

The usual number of reports on the use and effects of corpus luteum extracts have appeared in the literature. All those commercial extracts (and these are the extracts which were employed in the clinical articles reported) which the writer has examined have proved inactive biologically using the growth effect exerted on the rabbit uterus as a test. No further reports on the general pharmacological activity of corpus luteum are on hand.

The sole organotherapeutic preparation which can be relied upon is thyroid extract.

Its use in gynecology and obstetrics except in cases of gross deficiency of the thyroid secretion is still largely empirical.

Both pituitrin and adrenalin are hormones which exert purely local drug effects<sup>1</sup> and do not replace the functional activities of the glands from which they are derived. Therefore their exhibition is very limited. The extracts of anterior lobe pituitary, pineal, thymus and adrenal cortex (desiccated adrenal) now obtainable and in the dosage now employed show no or only unconvincing effects.

If the hormone theory as accepted at present and in proof of which so much correlated data have been accumulated in both the clinic and in the experimental laboratory, eventually is to find practical application and usefulness in therapeutics, the vital principles of some of the glands of internal secretion must first be isolated and the proper dosage and method of prescribing them must be discovered. Among these vital or essential glands should be classed the anterior lobe of the pituitary, the parathyroids, the adrenal cortex and pancreas. Neither the thyroid, thymus, pineal, ovary nor testis are essential to the continuance of life, although their secretions play a rôle of variable importance in the organism, a rôle not necessarily at once apparent after their ablation or atrophy.

According to our concepts of physiology specific cells produce only specific secretory products, so that while we may conceive that the cells of the gastric glands produce greater or lesser amounts of hydrochloric acid, we cannot conceive of their secreting lactic acid for example. Analogously we may accept that the specific cells of a given gland of internal secretion can elaborate one or more specific products, that this secretion may vary in amount or concentration but not that it may vary in character. If anything more than this variation in amount, concentration or rate of discharge into the blood stream, and such variations should be capable

<sup>1</sup>The peculiarly complex action of adrenalin, which facilitates the action of the small intestine, stimulates the constriction of the uterine muscles, dilates the bronchi, etc., is explained by the fact that the drug acts as stimulant of the sympathetic junctions of the sympathetic system and, therefore, produces the effect of general stimulation of sympathetic fibers. As these fibers act partly as accelerators, partly as carriers of vaso-motor factors, most diverse effects may be expected and actually occur.

of producing the most diverse phenomena is implied by dysfunction this term lacks all theoretical or experimental basis and should be dropped from medical terminology.

By discarding dysfunction the problem is much simplified. A hormone may then be regarded as the specific product of a secretory cell and a given type of cell can then be expected to produce only one (or more) secretion. Such specific secretory products as we understand most clearly produce distinct *drug actions* which may be simple and rapid as that of adrenalin which stimulates

the sympathetic nervous system or more slow and less immediately apparent in its effects as thyroid substance which increases the rate of metabolic activity. In any case a potent hormone derivative should have a pharmacological activity *which lends itself to standardization and which can be demonstrated by biological tests*. Until this entire concept is grasped and applied our efforts at organotherapy will remain in their present state of crude empiricism in exact parallelism with the crudity of diagnosis in disease of the glands of internal secretion.

## THE RELATION OF THE PITUITARY GLAND TO THE FEMALE GENERATIVE ORGANS

FROM THE EXPERIMENTAL AND CLINICAL ASPECTS

By EMIL GOETSCH, M.D. BALTIMORE, MARYLAND

**I**N view of the great interest which is being manifested more and more and because of the interesting and almost startling revelations which are accumulating in the field of endocrinology it is desirable that investigators and clinicians should at all times be able to distinguish between facts and theories in regard to the interrelationship of the ductless glands. There is great danger in discussions of the physiology and pathology of these organs to engage in fruitless theorization and suggestions unless there is a firm basis of well-controlled experimental and clinical observations to stand upon. On the other hand, one should preserve a mind open to suggestions and leads which are constantly being met with in studies on the ductless glands and should not approach the subject in too critical a manner simply because our knowledge of endocrinology at the present time is still very limited.

Many facts have been discovered which have aided us materially in understanding the involved syndromes met with in clinical cases exhibiting evident ductless gland disturbances. Particularly from the laboratory have come many enlightening discoveries and suggestions which have cleared away the

confusion surrounding the diagnosis and treatment of those unfortunate individuals who show the consequences of disturbances in their endocrine glands and who are appearing for treatment in constantly increasing numbers.

### I GROSS AND HISTOLOGICAL STRUCTURE OF THE PITUITARY GLAND

*Gross.* We have become more and more intimately acquainted in recent years with clinical evidences of disturbed function of the hypophysis. This gland also called the pituitary body is thoroughly protected by nature in being centrally located at the base of the skull and surrounded by a bony encasement called the sella turcica. It consists of the anterior or glandular part, which is considerably larger than the posterior or nervous part, and gives the gland its characteristic pinkish grey appearance in the fresh condition. The anterior epithelial part is further divided into the large pars anterior proper which constitutes about three fourths of the gland and presents a pinkish grey appearance and the posterior narrower zone of whitish appearance called also pars intermedia. The latter constitutes the

epithelial lining or encasement of the posterior lobe and extends upward along the infundibulum frequently even to the floor of the third ventricle. Between these two divisions of the epithelial or glandular portion lies the cleft the embryonic remains of the original cavity of Rathke's pouch.

*Histology:* There are two fundamentally different types of cells in the anterior lobe depending upon their affinity for stains the chromophilic which stain intensely with either the acid or basic stains and contain secretion granules whereas the chromophobe have no special affinity for either basic or acid dyes and are non granular. The pars intermedia which invests the posterior lobe is composed of several layers of undifferentiated cells without blood vessels or connective tissue stroma. These cells elaborate a kind of colloid secretion which is thought by some to find its way through the meshes of the posterior lobe into the third ventricle of the brain. It is probably this colloid material which carries the active principle of these cells, often called pituitrin. The cells of the anterior lobe without doubt discharge their secretion directly into the large blood and lymph sinuses which are so numerous here and with which the cells are in such intimate contact.

*Correlation between alterations in structure and function:* Disturbances in pituitary function are associated with changes in these anatomical constituents of the normal hypophysis. Thus hyperfunction is associated with focal or general hyperplasias of the chromophil cells, while hypofunction is associated with certain degenerations with atrophy and with tumor formation either of the hypophysis itself or as a result of pressure from tumors arising from a neighboring structure. Such pathological involvement is followed by symptoms of deficient glandular secretion as elsewhere in glandular organs.

## II INTERRELATIONSHIP IN FUNCTION BETWEEN THE PITUITARY GLAND AND THE FEMALE GENERATIVE ORGANS

It is my purpose to discuss in this paper our knowledge concerning the interrelationship between the pituitary gland and the female

generative organs. Perhaps between no two of the ductless gland series is a clearer association in function demonstrable, a fact supported by many experimental and clinical observations. In this paper I shall discuss first the former and then as a corollary to this shall consider second the clinical data bearing upon this subject. It seems desirable furthermore to consider principally those facts which have been well controlled experimentally and clinically and to mention only incidentally theoretical observations and suggestions.

### A EXPERIMENTAL EVIDENCE

1. *Pituitary deficiency:* On account of its difficulty of attack in an experimental way the pituitary gland was the last of the ductless gland series to receive serious attention at the hands of laboratory investigators. Practically all of our knowledge concerning this small gland has been gained during the last ten years. The first series of experiments which showed that pituitary and sex functions were closely interrelated, was that reported by Crowe, Cushing and Homans (1) who noted among many other changes that partial removal of the pituitary anterior lobe in dogs was followed by secondary hypoplasia of the organs of generation in adults, or by a persistence of sexual infantilism in case the operation was carried out on puppy dogs. There was a tendency to the disposition of fat much as seen in states of adiposity and of sexual infantilism in man. These changes following upon an artificially created deficiency of anterior lobe secretion are characteristic of both males and females.

It may here be interesting to mention some further striking results obtained by Aschner (2) who in 1912 published his findings after total and partial hypophysectomy in dogs. In adult animals there was observed a slight hypoplastic change in the sex glands and a definitely diminished sexual activity. In young animals the partial removal of the pituitary led to very marked and characteristic changes. There was an entire failure of development of the sex apparatus and of sexual activity in both males and females. The sex glands remained infantile in character. There was impotence and absence of spermatogenesis in the males and failure of ovulation and sexual instincts in the female. Furthermore hypophysectomy during preg-

nancy caused abortion. There was also marked retardation in corporeal growth and diminished general activity of the animals thus operated upon. Other characteristics noted were a certain psychic depression, subnormal temperature, persistent pappy type of hair, a thick inelastic skin, persistence of the milk teeth, failure of closure of the epiphyses and a delicate and underdeveloped condition of the skeleton. Certain rather constant changes were also seen in the parenchymatous organs such as increased size of the colloid alveoli in the thyroid, an abnormally persistent thymus, fatty infiltration into the liver and increased thickness of the adrenal cortex. Aschner regards the anterior lobe as mainly responsible for these changes. The writer has been able to confirm these findings in numerous instances.

The occurrence of adiposity along with the sexual infantilism is probably a result of deficiency of posterior lobe secretion. In a report by Goetsch, Cushing and Jacobson (3) upon experiments conducted to determine the relationship of the hypophysis and especially of its posterior lobe and infundibulum to glycosuria, polyuria, and carbohydrate metabolism they show that under various forms of operative manipulations of the infundibulum, hypophyseal stalk, and often of the posterior lobe itself a transient hyperglycemia is produced with an associated diminution in the assimilation limit for ingested carbohydrates. In many instances a transient spontaneous glycosuria was produced.

If the operation had been so conducted as to create a subsequent and permanent insufficiency of posterior lobe secretion the temporary lowering of the assimilation limit is succeeded by an abnormal and enduring augmentation in the tolerance for sugars.

The assimilation limit for carbohydrates, greatly increased under these circumstances, can be promptly lowered by the coincident intravenous or subcutaneous injection of posterior lobe extract. This extract, furthermore, has a pronounced effect in lowering the sugar tolerance of the normal animal, in whom it may even cause glycosuria when given in sufficient dosage.

*a Effects produced by pituitary extracts*  
In the foregoing we have considered the evidence obtained from experimentally created pituitary deficiency for believing that pituitary and sex functions are closely interrelated. The next step in the investiga-

tion is a natural one, namely, that of studying the results in animals, of the administration of fresh pituitary gland, dried extracts, fluid extracts or active principle in one way or another. For this purpose the hypophysis of various animals has been used such as that of the ox, horse, cat, dog, sheep and even man. The source of the gland extract seems to have little effect upon the results, so long as the particular extract used is an active one. The results obtained by many investigators who have worked on these problems cannot be fully discussed here. The results of many of the earlier workers have subsequently been shown to be wrong because of failure to distinguish between the extracts of the anterior and posterior lobes, whose properties we now know are distinct and different. Then again proper attention was not given to the question of dosage. We now know for example, that a dose which was administered to a young animal over a considerable period of time and which was obviously too large produced toxic effects and gave results precisely opposite to those obtained by other workers using small stimulating doses. Great difficulty was at first experienced in standardizing the strength of the extracts used, as a consequence of which investigators reported varying results following the use of extracts of varying strength.

*Extract of the posterior lobe* The physiological activity of extracts of the fresh pituitary was first investigated. Thus in 1895 Oliver and Schaefer (4) reported the results of their researches which demonstrated in the mammalian pituitary body an active principle with a specific effect upon the heart and blood vessels when injected intravenously. It was shown that this extract produced a general constriction of arterioles, leading to considerable elevation of blood pressure and an augmentation of the force of the heart beats.

Howell (5) subsequently pointed out that the posterior lobe alone possesses this property. Dale (6) was the first to describe the direct stimulating action of pituitrin (the active principle derived from the posterior lobe) on the uterine musculature. Blair



Bell (7) in addition described its stimulating action upon the musculature of the bladder. Frankl-Hochwart and Froehlich (8) experimented further with hypophysin, a pure extract of the posterior lobe and confirmed and elaborated the findings of Dale and Blair Bell. The galactagogue action of posterior lobe secretion, as described by Ott and Scott (9) and as further investigated by Mackenzie may be mentioned in passing as bearing out the relationship of the pituitary body to milk secretion during and after pregnancy. Whether this action of posterior lobe principle is one specifically stimulating to the secreting mammary cells or whether it produces its effect by causing contraction of the smooth muscle fibers around the ducts of the gland thus causing the expression of milk, remains an open question.

3 *Effect of feeding anterior lobe.* Many attempts have been made to simulate conditions of hyperpituitarism by feeding with fresh gland or glandular extracts over long periods of time. The primary object of these experiments was to study the effect upon the growth of the animals. The results reported vary greatly and probably to a large extent for reasons mentioned above. Practically no observations had been reported on the effect of experimental overstimulation with pituitary extracts upon the development and activity of the sex glands until the author's publication upon the subject in February, 1916 (10). Behrenroth (11) is the only previous author in so far as I have been able to discover who makes any special mention of an accompanying effect upon another of the ductless glands, produced by either the feeding or by the injection of pituitary extracts. He carried out the hypodermic administration of pituitary extract mainly for the purpose of observing its action upon the kidney blood pressure, and metabolism. He incidentally makes brief mention of the fact that in some of his animals early and extensive spermatogenesis was noticed. The results however were not constant and in female animals only slight changes were observed.

In view of the definitely retarding influence upon the growth of the sex glands produced

by partial extirpation of the pituitary gland, it occurred to the writer that it might be possible to produce premature sexual development and maturity and overactivity of the sex glands in young animals by the prolonged daily feeding of small doses of pituitary extract (anterior lobe) to young animals. Accordingly feeding experiments were carried out in young rats to which daily doses of .05 grams of the dried powdered extract of the anterior pituitary lobe were given over varying lengths of time beginning when the animals were weaned, which was usually at the age of  $3\frac{1}{4}$  weeks. The feeding of whole gland exerts its action by virtue of the anterior lobe extract which it contains, for it was found that the extract derived from the posterior lobe had no specific action upon the development of the sex glands.

The conclusions cited in the study mentioned above (p. 49) may be briefly repeated here.

In comparison with the development in control animals the ovaries, tubes, and cornua of the uterus of animals fed with whole gland extract (in which the anterior lobe is the responsible factor) are larger, more vascular and ordematous in appearance indicating increased development and activity. Even at the early age of 2.5 months, from one to two months before normal sexual maturity the ovary is matured and shows active ovulation and graafian follicle formation, relatively few primordial follicles, and some increase in the amount of interstitial tissue. This striking appearance in so young an animal gives the impression that an early ovarian maturity has been produced by the feeding of the pituitary extract. The fimbriated end of the tube is more branched and the lining columnar cells are more ciliated, an indication of greater activity. There is marked hyperplasia of the uterine mucosa, the lining cells of which are more uniformly ciliated and active and there is abundant gland formation in the endometrium. The appearance presented by the latter strikingly resembles in microscopic appearance the hyperplastic endometrium of early pregnancy. There is generally increased vascularity produced in the whole sexual system. The overdevelopment is apparent even in the muscle coat of the uterus which is considerably thickened and is also more vascular. A somewhat similar change is produced by the feeding of corpus luteum to the female but not to the same degree as after anterior lobe administration.

And again the feeding of pituitary anterior lobe extract to rats over prolonged periods was studied with the following results (p. 49)

After prolonged feeding of anterior lobe extract over a period of eight or nine months the sexual instincts are early awakened along with the early maturity of the sex glands. As a result of this, a pair of rats after anterior lobe feeding over a number of months bred earlier and oftener the female of this pair having two pregnancies in seven months as compared with none in the female of the control pair. The effect of the anterior lobe feeding lasts throughout the adult life of the animals. The control rat never reaches the degree of development and activity shown by the animal receiving the anterior lobe extract. For even at the age of ten months after 8½ months of anterior lobe feeding the latter still shows a greater, more active and mature sexual development than the control.

The feeding of pituitary anterior lobe to parent rats exerts its stimulating influence upon the offspring in intra uterine life and during lactation and, when the experiment is carried further and the feeding to the young is continued after weaning it has an even greater stimulating effect upon growth weight and development and causes earlier and more frequent breeding and an increased number of offspring in the litters. The stimulating effect upon the sex gland is greater the longer the influence of anterior lobe administration is exerted.

The extract of pituitary posterior lobe, even after prolonged administration does not stimulate growth in general nor the development of the sex glands as does anterior lobe even after a very short period. Thus, for example, there is a much less marked development of the sex glands after administration for 2-4 months. The posterior lobe element in the whole gland extract has an undoubted retarding influence upon the development of the sex glands, an effect very similar to that of ovarian extract upon the testes. This is shown by the relatively incomplete development of the testes, for example after 8½ months of posterior lobe feeding. If given in too large doses the extract causes in the rats loss of weight, a mild enteritis and increased intestinal peristalsis.

A striking illustration of the effect of pituitary feeding in the young female rat is afforded in Figs. 1 and 2. The pituitary fed animal matures prematurely and the ovary shows the presence of corpora lutea. The ovary of the control female is still immature.

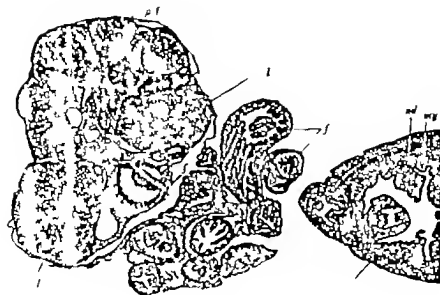
In Figs. 3 and 4 the remarkable hyperplasia of the endometrium as a result of pituitary feeding is seen a reaction so remarkable as to simulate the appearance of early pregnancy. A great increase in the number of uterine glands is also seen in the case of animals receiving gland feeding. The other changes are self evident in the drawings.

## B. CLINICAL EVIDENCE

Turning now from the experimental evidences of a close interrelationship in function between the pituitary body and the genital system to similar conditions in the human subject bearing out this relationship we find that these have attracted the attention of the clinician. It has been found convenient to apply to the clinical types of pituitary disease certain terms which express simultaneously our conception of the activity of the gland in these states of disordered function. In the case of the thyroid a definite symptomatology was established for conditions of overaction of the gland and called

hyperthyroidism with exophthalmic goiter as the well known example similarly for conditions of underactivity of the gland called hypothyroidism exemplified by myxedema in the adult and cretinism in childhood. Just so analogous terms were chosen for states of over and underactivity of the hypophysis, namely hyperpituitarism and hypopituitarism. Practical difficulties were however encountered in attempting to place all types of pituitary trouble in these two groups for conditions of presumed overactivity frequently merge into states of underactivity so that symptoms characteristic of both states blend one with another just as in the case of the thyroid symptoms of myxedema are engrafted on the picture of Graves disease. Then again in the pituitary we are dealing with two separate lobes, either one of which may become the seat of disease without the involvement of the other or one may become adenomatous and clinically overactive, and by pressure upon the other lobe may impair its function and cause a condition of underactivity of this part. To designate this large group of pituitary diseases the term dyspituitarism has been used.

In considering the symptomatology of pituitary disorders it is convenient to think of it in terms of local symptoms due to pressure by the enlarging pituitary body upon important neighboring structures and of general glandular manifestations consequent upon changes produced by excessive or deficient pituitary secretion. The change may be



Female pituitary gland.  $\times 95$  (See description under Fig. 1)

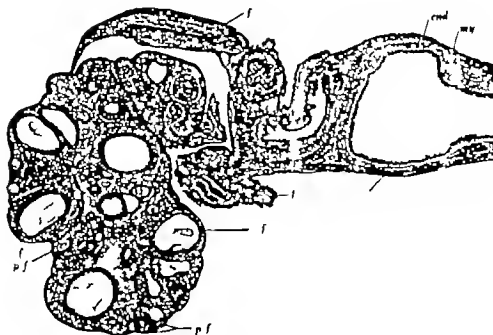
primarily due to the excessive secretion itself or secondarily due to consequent disorder in the other ductless glands such as the genital glands reference to which will be made shortly.

Pressure upon part in the immediate neighborhood of the pituitary is occasioned mostly by hyperplasia or tumor growth of the gland itself. The principal pressure symptoms thus caused may be briefly mentioned. They are headaches, usually bilateral, and due probably to distention of the dural envelope of the gland. If the tumor enlargement encroaches upon the intracranial space general headaches, frequently with vomiting, choked disc superimposed upon primary optic atrophy and disturbances due to pressure upon important neighboring cerebral areas may result. Frequently there is absorption varying in degree of the bony walls of the sella turcica the study of which has been aided so much by the X ray. The optic nerve is early involved with resultant characteristic types of blindness. In the more severe grades of general intracranial pressure, convolutional pressure markings on the inner surfaces of the bones of the cranial vault may be recognized by the X ray.

The general glandular manifestations document themselves in changes in growth, in

cutaneous and subcutaneous changes, in adiposity and alteration in the carbohydrate metabolism and tolerance in urinary changes, in variations in body temperature blood pressure in mental disturbances and in secondary disturbances in other of the ductless glands, particularly the genital glands. Histological alterations are known to occur in the thyroid, adrenals, thymus, pancreas, and pineal but they possibly are less definite and of less significance than those found in the genital glands and will not be considered in greater detail at the present time.

**Hyperpituitarism.** Clinical hyperpituitarism is now quite generally considered to be due to overactivity of the pituitary anterior lobe secondary to adenoma or hyperplasia of this anatomical division of the gland and evidenced histologically by a great increase in the number of eosinophile or acidophile cells. If this condition antedates puberty the resulting condition is known as gigantism on the other hand if the hyperpituitarism develops in the postadolescent period the well known disease, acromegaly, develops. We are acquainted with examples of excessive sexual libido occurring in the early stages of the latter and with cases of premature acquisition of sexual power and secondary sex characteristics if the hypophy-

FIG. 2. Female II (control)  $\times 85$ 

Figs. 1 and 2 represent in one plane the ovary, the fimbriated end of the tube and the beginning of the uterine cornu of two young rats, 2½ months old, of the same litter to the first of which (Fig. 1, Female I) pituitary extract (whole gland) was given over a period of 43 days from the time when the animal was 30 days old, the second the control (Fig. 2, Female II) received no glandular feeding. Both animals were sacrificed when they were 7 days or 2½ months old. Compare in Fig. 1 the presence of corpora lutea (c l), the scarcity of uterine follicles (u f), the marked endometrial hyperplasia in the uterine cornua (m c), the proliferation of the fimbriated end of the tube (f) and the increased vascularity in the hilus of the ovary, with (in Fig. 2) the number of uterine granulosa follicles (g f), the absence of corpora lutea, the smaller degree of branching of the fimbriated end of the tube (f) and the simple thin mucous membrane in the uterine cornu (m c). p f, Primordial follicle. End, endometrium. my, myometrium.

seal overactivity antedates normal adolescence. After a period of hyperplasia and hyperactivity of the pituitary, particularly the anterior lobe, the gland undergoes a retrogressive alteration as shown by the stromous tumor formation and the tendency to cystic degeneration of the pituitary so frequently found in the later stages of acromegaly. It is for this reason without doubt that so much confusion has arisen in interpreting the sexual changes occurring in the disease, but if we remember that the pituitary gland itself undergoes a kind of involution from a hyperactive to a hypoactive state in acromegaly, then we can readily comprehend the early increased libido and hyperactivity of sexual function and the late loss of libido and incidence even of impotence in the male and cessation of menses with sterility in the female.

In the final stage in both sexes a high degree of atrophy of the sex glands develops. Indeed it is not uncommon for the gynecologist to be the first to be consulted by the patients suffering from these pituitary disorders because of the disturbing genital changes. If it were possible to examine the sex glands in the early stages of gigantism and acromegaly, one would in all probability find histological evidences of very active spermatogenesis in the male and abundant ovulation in the female. Since, however, the sex glands at autopsy are examined in almost all instances in the late stage, we find only evidence of hypoplastic change. Thus in gigantism we find skeletal overgrowth combined with genital hypoplasia and imperfectly acquired secondary sexual characteristics and in acromegaly we similarly have the well known bony overgrowth and retrogressive sexual



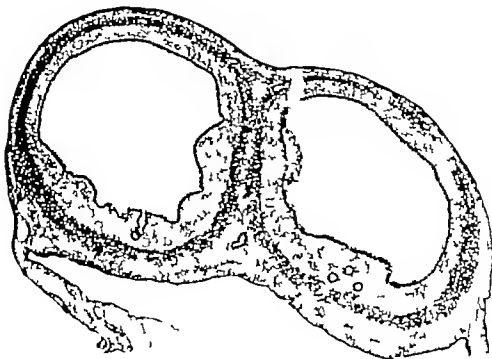


FIG. 4. Femal II (control)  $\times 24$ .

FIG. 4. Section taken from the control animal at a point corresponding to that represented in Fig. 3.

to the endometrium the marked hypertrophy and hyperplasia of the uterine mucosa with active glandular activity suggesting the pregnancy reaction the erythrocytic character of the prozona and the increased thickness of the musculature of the myometrium (in Fig. 3 as compared with Fig. 4 (control)). From the *Bulletin of the Johns Hopkins Hospital* 1906, vol. 35, 36.

while the eosinophilic cells markedly decreased in number are crowded aside into the more central portions of the gland acini. The histological picture thus afforded is very striking. The hypertrophy of the pituitary occurring in the later stage of pregnancy may become so marked as to exert pressure upon the adjoining optic chiasm sufficient to cause a transient bitemporal hemianopsia, cases of which have been reported from time to time. Associated with this hypertrophy occurring in pregnancy there may be signs and symptoms attributable to a temporary hyperfunction of the pituitary such as definite change in thickness of the nose and face and enlargement of the hands and feet. Similarly a transient glycosuria may be found possibly due to transient hyperfunction of this gland. Within a few months postpartum retrogressive changes occur the pregnancy cells return to the type of chief cells and the gland once more assumes its normal appearance. The involutions of the gland may be

incomplete and after repeated pregnancies there may result a kind of strumous degeneration followed by symptoms dependent upon a deficiency in pituitary secretion.

2. *After castration.* On the other hand in castration both in animals and in the human it has been shown that there is a consequent hypertrophy of the hypophysis. Fichera (15) was the first to demonstrate that in a series of castrated animals of different species, including the cock, ox, buffalo, guinea pig and rabbit, there was a definite increase in the weight of the hypophysis, relatively greatly in excess to the increased growth of the animal. Histologically in addition to the hyperemia there was an increased number of eosinophiles. Tandler and Grosz (16) were similarly able to show an hypertrophy of the pituitary body in the castrated human as indicated by enlargement of the sella turcica demonstrable by the X-ray in the living and by examination of the skeleton after death. Tandler (17) showed that a

pituitary hypertrophy following castration occurred not only in the skopten sect of eunuchs, but that the same condition occurred also in castrated women. For a more detailed account of the genital changes occurring in clinical cases of pituitary disease the reader is referred to the case reports and particularly to Part III, pp. 275-300 of Cushing, (16) comprehensive enough in *The Pituitary Body and Its Disorders*.

#### IV. THE USES OF POSTERIOR LOBE EXTRACT IN OBSTETRICS AND IN INTERNAL PAINS.

1. *In pregnancy.*—Very soon after our understanding of the action of pituitary extracts upon the genital system became more definite these substances were applied therapeutically in clinical cases. Thu Herzberg (20) used intramuscular injection of an active pituitary product called hypophysin in cases of pregnancy with apparent success in causing more powerful contraction of the uterus during parturition. Because of its characteristic stimulating action upon smooth muscle generally and particularly and almost specifically upon the pregnant uterus, pituitary extract (posterior lobe) has come into wide use in obstetrics. The extract on the market is known as pituitary liquid or as pituitrin. It is a carefully prepared solution of the active principle of the posterior lobe and can be standardized by the isolated uterus method. This latter method enables us to know the exact strength of solution which we are using. Pituitary liquid represents the active principle of the pituitary posterior lobe in normal salt solution and is put up in 1 cubic centimeter ampoules convenient for hypodermic use. According to Fenger (21) The uterine contracting principle of the posterior lobe of the pituitary body is readily extracted from the fresh glands by water and also by neutral and acidulated methyl or ethyl alcohol. The acidulated methyl alcohol extract is more than twice as strong as the water extract and somewhat stronger than the pure crystalline B-imidazolyethylamine hydrochloride.

Pituitary Liquid is now official in the new pharmacopœia.

In an article entitled "Observations on

Pituitary Extract in Obstetrics," published in May 1915 Rowland (22) reports the results of a careful study on the use of pituitary posterior lobe in a series of obstetrical cases. I shall borrow freely from this report in my consideration of this phase of our subject.

The easy administration of the drug, the very satisfactory result in properly selected cases, the apparent harmlessness of its use, the apparent saving of many cases from operative delivery and particularly the almost immediate termination of labor after hours of tiresome waiting by the physician and of painful and exhausting labor for the patient all make a very strong appeal to the obstetrician. For this reason the dangers of pituitary administration of their real dangers in its use should be impressed upon those using the drug.

The uterine contractions caused by hypodermic administration of the drug last from 30 minutes to about two hours or longer with an average duration of about an hour. They are increased in intensity and the intervals diminished. In cases of labor the effect of the drug is first shown in less than ten minutes after administration. The contractions experimentally induced are in the beginning not accompanied by pain and in cases of the second stage the great increase in strength and efficiency of contractions does not seem to be accompanied by a marked increase in the patient's suffering. Exceptions, however, do occur. The contractions are not tetanic in character though sufficiently continuous and severe in some cases to cause concern if there is obstruction or a diseased condition of the uterine wall. There is usually an increase in the blood pressure independent of the intensity of the pain set up with an average increase of about 18 to 24 milligrams of mercury. The increase is usually gradual for about 20 to 30 minutes followed by slow return in the course of an hour to the pressure present before injection. From the standpoint of toxicity the drug seems on the whole to be harmless. There are cases however of individuals who seem to possess an idiosyncrasy toward the drug and who respond to it by having nausea and vomiting and in some instances even collapse.

There seems no doubt now that labor can be induced by the use of pituitrin. By its use it may be possible to terminate a full-term pregnancy when it is desirable to do so. The use of pituitrin is dangerous in cases where there is failure of the cervix to dilate and when the head fails to advance and engage. Marked disproportion between the head and pelvis furnish probably the strictest contraindications to its use. In proper cases, a head which has resisted the unaided efforts of the uterus to engage it may be quickly engaged and advanced so that a forceps delivery may be done. However dangers arise when the pituitrin fails to

do what is desired and there arises a demand for immediate delivery for then other valuable methods for rapid delivery are made impossible. A few cases of rupture of the uterus have been reported when the drug was used in the first stage of labor. It is useful in the first stage of cases of placenta prævia in conjunction with tampon or balloon and in cases of pre-eclamptic toxæmia eclampsia or nephritis when the increase in blood pressure is not considered of itself dangerous.

It is in the second stage of labor however when pituitrin is most valuable. In considering its use here I can do no better than quote from Rowland's observations:

All authorities agree that the period of greatest usefulness of the pituitary preparations is during the second stage of labor. Many women are able to fully dilate the cervix but make no further progress or may fail to engage a head in the slightly contracted pelvis or may advance the head partially through the birth canal or may even bulge the perineum with the advancing head or breech, and then succumb to exhaustion. For one reason or another it is the second stage which has usually brought the exhaustion, fatal to the hopes for spontaneous delivery. It is here that the remedy shows its almost magical quality terminating sometimes in a few minutes cases which have dragged to an almost interminable length or quickly changing a slow and exhausting second stage with weak and far apart and insufficient pains into vigorous forceful and efficient bearing down pains which make the patient and her friends as well as the attendant have hope of a speedy termination. No other remedy or method of delivery can bring when successful such a change in the outlook of what has been a tedious and wearisome case. It will make an easy low forceps sufficient when a difficult high forceps would otherwise have been necessary. It practically does away with the cases which otherwise would terminate in a low forceps delivery.

There are certain disadvantages and dangers in the use of pituitrin which should be mentioned. It should not be given at all or administered with the greatest caution when there is obstruction or a diseased or weakened condition of the uterine wall. There is more damage to the perineum than in corresponding cases delivered spontaneously but the disadvantage is offset by the number of forceps deliveries from which patients are saved. There is danger of asphyxiation of the child if for any reason delivery is delayed while the placenta is being separated from the uterus. The sudden and rather prolonged rise of blood pressure may be a complicating factor in some instances. The possibilities of rupture of the uterus have been mentioned. Certain other advantages may be cited. There is less hæmorrhage after delivery. Pituitrin however has not displaced ergot in stopping hæmorrhage.

It has been claimed by some that pituitary liquid will distinguish between pregnancy and labor the basis for the differentiation being that a small dose of the drug ( $\frac{1}{3}$  cubic centimeter) will start uterine contraction if pregnancy has reached term but if administered before term the effect is transient and additional doses will have no effect. It seems that when thus used the drug sensitizes the pregnant uterus but does not stimulate strong contractions.

In the obstetric clinic of the Johns Hopkins Hospital Williams is making rather extensive use of pituitary liquid. The indications for its use have been grouped under three heads.

In the first place pituitary liquid is used in primiparae only when the head is beyond the spines and on the perineum thus assuring free passage to the head. In multiparae it is used frequently even when the head is at the spines no bad results having been seen in its use at this stage. The general results have been very satisfactory and as a consequence of this therapy there has been a very considerable reduction in the use of forceps.

The second use of this drug by Williams is for the arrest of hæmorrhage postpartum, instead of ergot. It acts more rapidly than ergot—inside of 3 to 5 minutes—and is always followed by the latter given hypodermically. In cases of severe hæmorrhage, or in which further hæmorrhage is feared ergot may also be given by mouth. The reason for this mode of treatment lies in the fact that the effect of pituitary liquid is rather transient the subsequent administration of ergot being intended to cause continued contraction of the uterus after the effect of the pituitary drug has worn off. For a similar reason pituitary liquid is used in cases of complete uterine atony after forceps have been applied.

The third use is in cases of cesarean section in which this drug is used as a prophylactic against hæmorrhage. Formerly a hypodermic of 2 ampoules (1 cubic centimeter) of the drug was given just before the beginning of the operation. This time was chosen on a basis of allowing 3 minutes for delivery since the action of the drug is rather rapid. However in cases of inability to deliver in 3 to 5 minutes as a result of operative difficulties there is a distinct danger of asphyxiation of the child. Consequently this mode of administration was given up and a change was made in the time of injection of the drug. At present the syringe is ready the ampoules are previously sterilized and the injection is given directly into the posterior wall of the uterus just as soon as the baby is delivered. The action of the drug is very rapid the uterus contracts powerfully and usually becomes board like in  $1\frac{1}{2}$  to 2 minutes. This treatment has now become the



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ery wll fact ry

The pituitary l... gl... n... ll n... Will m...  
cll... n the prim... stag... w... bor... l... t... we earlier  
ln... es ln wh... h... l... w... giv... at this stag...  
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No... serious... ul... peri... l... th... w... r...  
the principal... la... rs... t... h... ul... be mentione... l...  
are rupture... f... l... t... h... th... drug...  
giv... n the first... tage... h... en... th... ry... n... t...  
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ut... fine wall... Th... s... on... l... mal... t... l... n... g... asphy...  
iat... n... f... th... h... uld... h... ow... ses... h... l... l... l... l... ry...  
absolutely... bec... l... m... s... l... l... The drug... t...  
n... 3... to... 10... ut... nd... l... fl... l... t... l... th... x...  
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th... e... t... n... t... pituitary... l... y... l... r... th... r... n... s... e... l...  
there... a... l... l... t... det... u... s... e... r... g... t... wh... h... used...  
ery... x... i... l... ly... secondary... t... th... p... r... ious... treat...  
ment... w... th... pituitary... liqui... l... The... l... ter... t... h... w...  
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derable... s... l... e... r... the... r... l... f... of... this... n... l... n...  
the... ir... at... t... u... s... th... same... h... th... the... pat... n... t...  
primiparous... multiparous... ma... N... l... l... l... g... e...  
bl... after effects... t... m... the... t... r... in... t... r... a... s... f... th...  
drug... h... e... been... observed... u... h... n... a... s... v... m... t... g...  
oil... p... re... or... th... u... l... es... of... the... l... l... u... t... r... y... t... e... m...

2. In *intelleltual parvi*... l... l... e... use... d... it...  
stimulating a t... n... upon the... m... th... mu... cu...  
lature of the bowel pituitary liquid has been  
used rather extensively for intestinal paresis  
and distention following abdominal and  
pelvic operation. The dose used varies from  
0.5 to 1.5 cubic centimeters injected intra-  
muscularly in the gluteal region. The first  
dose is usually given from four to six hours  
after operation and may be repeated a num-  
ber of times at interval of four to six hours  
according to indication. According to the  
reports published no serious results seem to  
have followed this treatment. In many cases  
markedly beneficial effect have been ob-  
served such as early passage of flatus, cessa-  
tion of abdominal discomfort, and a freer  
movement of the bowels. Catheterization  
seems to be less frequently necessary on  
account of postoperative retention of urine  
since bladder irritability is also increased by  
injections of pituitary liquid. The injections  
should be given intramuscularly because the

subcutaneous injections are apt to produce  
considerable pain and may be followed in  
certain instances by local necrosis.

#### V. THE USE OF PITUITARY EXTRACTS IN DISTURBANCES OF THE PITUITARY GLAND

Considerable success has furthermore been  
attained by the oral or hypodermic adminis-  
tration of pituitary extracts in clinical cases  
of pituitary disease exhibiting among other  
symptoms the characteristic sexual dis-  
turbances such as amenorrhea and sterility  
in the female and the loss of libido and  
potentia sexualis in the male. A number of  
such cases have been recorded by Cushing  
(19) in which after administration of pituitary  
extract by mouth there has been a return  
in part or entirely of menstruation and of  
libido and potentia. It seems probable that  
in condition interfering with the normal  
function of the pituitary gland both the ante-  
rior and posterior lobes are involved and  
that we therefore see in the corresponding  
clinical states symptoms due to disturbances  
in both lobes. Reference was made in a  
previous section of this paper to the experi-  
mental fact which showed that a deficiency  
in posterior lobe secretion is followed by a  
tendency to the deposition of fat and to  
changes in metabolism such as an increased  
tolerance for carbohydrates and that these  
changes can be favorably influenced by the  
administration of posterior lobe extract.  
The genital disturbances which follow defi-  
ciency in pituitary anterior lobe function and  
which are associated with these changes just  
mentioned are benefited by the adminis-  
tration of anterior lobe extract. It follows then  
that in order to obtain the greatest benefit  
in clinical cases which combine the symptoms  
of deficiency of both pituitary lobes, one  
should administer the whole gland extract  
derived from both lobes of the gland.

Since many clinical states may present  
symptoms often very similar and yet depend-  
ent upon a different etiology patients may  
complain of disturbances in genital function  
dependent upon changes primarily in the sex  
gland or secondarily due to disturbances in  
pituitary function. It is of advantage in the  
treatment of these cases to determine in so

far as this is possible, whether the symptoms complained of are pelvic or pituitary in origin for it seems definitely shown that better results are obtained when the extract of the gland primarily deficient is given and perhaps supplemented by one or more extracts of the glands secondarily involved. Thus in a case presenting a symptomatology clearly pituitary in origin with secondary ovarian involvement, emphasis should be placed upon pituitary feeding supplemented by ovarian or corpus luteum administration and in a case in which the opposite is true, the converse method of glandular feeding should be instituted. In a series of cases illustrating types of genital under function and adiposity recently reported by Vest, (23) in which marked improvement followed the administration of ovarian and corpus luteum extracts it is possible, as the author suggests, that even greater benefit might have been derived by the supplemental feeding of pituitary extract. This would seem to be the case particularly with reference to the adiposity which could be explained by a coincidental underfunction of the pituitary. Indeed, the degree of reduction of the adiposity and the carbohydrate tolerance which is usually high might be used as an index to the dosage of gland extract which should be used. At times in cases exhibiting polyglandular manifestations, small amounts of thyroid extract or even adrenalin may with benefit be added to the pituitary feeding. In addition to the improvement in the specific symptoms complained of there is improvement also in the associated symptoms. Thus subnormal body temperature again becomes normal the blood pressure rises, constipation is less troublesome and there is less drowsiness and mental inactivity. In gigantism and acromegaly it is obviously necessary to determine whether the disease is early and in the stage of pituitary overactivity for at such a time administration of pituitary extract might well result in exacerbation of the symptoms complained of just as the symptoms of exophthalmic goiter may be aggravated by thyroid administration.

Unfortunately in the present state of our knowledge, organotherapy is largely empirical

The principal reason for this lies in the fact that thus far it is impossible to determine how much active principle is contained in a given amount of the dried gland extract such as is used so largely in the treatment of clinical cases. Certain active liquid preparations are at present prepared by the larger pharmaceutical firms but the difficulties accompanying often repeated hypodermic injections are too obvious to need mention. The latter method of administration, however is the most effective and the most satisfactory if not continued over too long a period of time.

A uniform method of standardization of the extract used is very essential for successful therapy. Fortunately the feeding of pituitary extracts is unaccompanied by any special dangers such as are known to follow the administration of thyroid extract. In fact Cushing reports that in one of his cases in the late stage of acromegaly he gave as high as 100 grains daily of whole gland pituitary extract in order to get the desired benefit. A convenient dosage to begin with is one which represents the administration by mouth of 5 grains of actual dried extract three times a day increasing until improvement is noticed. It should be noted here that many of the tablets placed in the hands of the profession contain accessory substances used in their manufacture and hence represent much less of the active gland substance than their weight might indicate.

Attention should be drawn to this point, as otherwise a patient might well receive a dose considerably smaller than is desired and intended. The amount of extract of other ductless glands and the mode of combination naturally would depend upon the indications in the case. Unfortunately this again of necessity is empirical, and one can be guided only by the effects produced. The greatest benefits derived from gland therapy are those obtained by correct and patient administration over considerable periods of time from three months to a year or more. Both experimental and clinical experience has shown that specific results are only obtained after a considerable lapse of time and many of the failures reported are undoubtedly

due to too short duration of gland administration. Then again the dosage may be too small to produce results when an increase would be of distinct benefit. Thus with pituitary extract it often becomes necessary to increase the amount of gland until a definite therapeutic effect is shown.

#### VI. SUMMARY

Perhaps between no two of the ductless glands is a closer interrelationship in function demonstrable than between the pituitary and the sex glands. There is abundant evidence available at the present time for believing that such a close association in function exists. We know from experiments in which the pituitary gland has been partially removed in dogs that a deficiency in pituitary secretion thus produced is followed by underdevelopment, genital inactivity and hypoplasia in young animals, and by impotence and sterility and retrogressive changes in the sex glands together with adiposity in case the animals were adult at the time of operation. Conversely after primary alterations in the sex glands, as is seen in pregnancy or after castration there is a consequent hyperplasia and hypertrophy of the pituitary gland. Overstimulation of young animals with the extract of pituitary anterior lobe is followed by overdevelopment and marked increased activity of the sex glands. Even histological evidences of such increased function are apparent, such as premature sex development evidenced by early and abundant ovulation in the female. It is the secretion of the anterior lobe of the pituitary which is responsible for these sex changes, whereas the posterior lobe secretion has an important function in regulating certainly in part, carbohydrate metabolism absence of this secretion being followed by a tendency to adiposity.

Clinical hyperpituitarism is well exemplified in the diseases, gigantism and acromegaly now generally believed to be due to an overfunction of the anterior lobe of the pituitary gland consequent upon adenomatous hyperplasia. In the early stages of these diseases we find an exaggerated sexual activity and libido and in the late stages corresponding

with pituitary involution and inactivity a disappearance of the sexual function. The sex glands in this late stage show histologically atrophy and various forms of degeneration. Similarly, inactivity and atrophy of the sex glands, is seen in clinical cases of primary hypopituitarism dependent upon pituitary underfunction following upon diseases of this gland or of its neighborhood compromising its function.

Pituitary extracts have gained wide usage in therapy. Thus pituitrin or pituitary liquid derived from the posterior lobe (together with pars intermedia) because of its stimulating action upon the smooth musculature of the uterus and bowel is used very extensively and satisfactorily in obstetric practice and for the relief of abdominal distention and intestinal paresis following surgical operations in the abdomen or pelvis.

As a result of the facts learned from the experimental feeding of pituitary extracts, particularly of the anterior lobe we should feel encouraged in our efforts to benefit clinical states dependent upon underfunction of this gland in the human. Thus, for example, a number of clinical cases showing among other symptoms, characteristic sexual disturbances (irregular menstruation amenorrhea, sterility) dependent upon primary pituitary disease, have been so greatly benefited that there have been a return of menstruation and libido even when these had been absent for a considerable period. It is probable that many clinical conditions showing genital aplasia, adiposity and underdevelopment and dependent upon changes in one or more of the ductless glands other than the pituitary, would be benefited by the feeding of pituitary extract in addition to the extract of the gland which is primarily involved. On the other hand the feeding of extracts such as thyroid and adrenal, combined with pituitary in clinical cases of pituitary diseases in which symptoms referable to these glands are present is advisable.

#### CONCLUSIONS

1. There is a close interrelationship in function between the pituitary and sex glands, a fact supported by abundant experi-

mental evidence and by numerous observations on pituitary disturbances in the human subject.

2 Overfunction of the pituitary anterior lobe is associated with overactivity of the sex glands

3 Deficiency of pituitary secretion in the individual is followed by underdevelopment and genital aplasia in the young and by sexual inactivity and retrogression in the adult.

4 Primary alterations in the function of the sex glands as in pregnancy and after castration, are followed by pituitary hypertrophy and hyperplasia

5 The specific action of posterior lobe extract ( pituitrin, pituitary liquid ) upon the smooth musculature of the uterus and bowel has led to the wide usage of this drug in obstetrical practice and in the treatment of intestinal paresis following abdominal and pelvic operations

6 The administration of pituitary extracts is of distinct benefit in clinical states of pituitary underfunction

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## THE PHYSIOLOGICAL AND PATHOLOGICAL IMPORTANCE OF THE PARATHYROID GLAND FROM THE EXPERIMENTAL ASPECT

BY CARL VOEGTLIN, PH. D. W. SHRYVER

OUR present knowledge of the parathyroid gland can be traced back to the early studies of the physiologist Schiff who on extirpating the thyroids of dogs observed in some cases the clinical symptom known as tetany. Schiff however did not associate these symptoms with the absence of the parathyroid gland in his animals as the existence of these glands was unknown in his time. The year 1880 marks the beginning of the rational study of the parathyroid gland as in this year Sandstrom discovered the gland and sometime later Gley attributed to it a separate function from that of the thyroid.

In spite of the fact that the anatomy and histology of the parathyroid differ in many respects from that of the thyroid, some investigators still continued to consider these two glands to be intimately related to each other. As a result of the splendid researches of Gley, Vassale and Generali, Erdheim, MacCallum and many others, it is now generally accepted that the thyroid and parathyroid are glands with distinct and separate functions. Thus it was shown that the complete extirpation of the thyroid alone leads to hypothyroidism with typical manifestations such as occur in myxoedema and cretinism. In contrast to these observations, it was found that the complete removal of the parathyroids alone leads within a few days to the appearance of tetany. The clinical pictures of these two conditions, i.e. hypothyroidism and tetany differ so much from each other that one is forced to believe that the two glands possess separate functions. Whereas removal of the thyroid leads to a chronic disturbance of metabolism which is not necessarily fatal, the complete absence of the parathyroid is always followed by the death of the animal. The vital importance of the normal functions of the parathyroid gland for the higher animals is, therefore, self-evident.

Unfortunately our information of the

physiological function of this gland is still inadequate. The only method so far available to study this problem has been the experimental production of tetany or hypoparathyroidism. By these means it is at least possible to study the changes occurring in the animal body as a result of the absence of the parathyroid gland. The most suitable laboratory animals for this purpose are dogs, albino rats, and cats. With some experience all of the parathyroids can be extirpated from these animals with very little injury to the thyroid. Recovery from the operation is usually very rapid and the animal is of normal appearance a few hours later. Within a few days, however, the animals develop a state of hyperexcitability characterized by muscular twitchings involving the skeletal muscles of part or of the whole body, fibrillation of the tongue, tachycardia, tachypnea, hyperexcitability of the peripheral nerves to the galvanic current, and increased reaction to the drugs stimulating the sympathetic nervous system. This period of hyperexcitability is usually followed by a state of depression. The animal is very quiet and refuses food. The periods of hyperexcitability and that of depression are obviously due to quite different conditions and although the hyperexcitability is more evident, the fact should not be forgotten that the depression may be a manifestation of hypoparathyroidism. The state of depression may later on be followed periodically by hyperexcitability, a fact which may have a definite underlying cause in the metabolic changes occurring after parathyroidectomy.

### NATURE AND CAUSE OF PARATHYROID TETANY

Tetany has been regarded by many authors as an intoxication by metabolic products. That the metabolism of parathyroid ectomized animals is, in many respects, abnormal will be discussed later. The question which concerns us here is whether tetany is a

true intoxication in the sense that abnormal and toxic metabolic products are present in the body or whether tetany is primarily due to an accumulation or overproduction of metabolic substances normally formed. Both conceptions are reasonable and do not stand in flat contradiction to the experimental facts.

It would probably be best to present here briefly the facts so far discovered having a bearing on the cause of tetany. This will be preceded by a short description of the symptoms of tetany as they appear after complete parathyroidectomy in experimental animals.

On carefully exposing the thyroid lobes of a dog one notices several small bodies adhering more or less firmly to the thyroid. These bodies represent the parathyroid glands and can be removed causing little damage to the thyroid. A few days after the operation twitchings are noticed in the skeletal muscles and also in the tongue of the animal. These symptoms gradually increase in severity to such an extent that the animal is forced to lie on its side with its legs stretched out on account of spasticity. Extreme tachycardia and tachypnea are common symptoms at this stage of the disease. There is usually a rise in body temperature during active tetany. The attack may pass over after having lasted for several hours and the animal is then usually in a condition of depression, taking no interest in its surroundings. After a day or two the symptoms of hyperexcitability may reappear and this be followed again by depression. Death takes place during an attack of hyperexcitability or more often during the stage of depression.

The peripheral nerves during tetany show a marked increase in irritability to the galvanic current. Falta and Kahn believe that the sympathetic and parasympathetic systems also are in a state of hyperexcitability as evidenced by the increased reaction by this system to certain drugs (epinephrine, pilocarpine). It should be emphasized that increased nervous irritability is not only associated with the visible muscular twitchings but is constantly present although to a lesser extent even in periods of depression. This abnormal condition of the nervous

system is probably not limited to the peripheral nerves but is characteristic of all nervous tissues in tetany, a fact which might find its explanation in a definite abnormality of the body fluids in this condition.

These considerations have led to attempts to control tetany by means of the administration of normal body constituents.

The work of Loeb, Sabbatani and others has shown that salts of bivalent metals with few exceptions (barium) have a depressing action on the nervous system. It was therefore reasonable to test the action of these salts on animals in tetany. The results obtained by MacCallum and Voegtlin, Parhon and Urech and many others demonstrate that an intravenous injection of any soluble calcium salt (chloride or lactate) almost instantly removes the visible symptoms of tetany as well as the abnormal irritability of the peripheral nerves to the galvanic current. Strontium salts were shown to have an identical action as that of calcium salts. Magnesium salts also removed tetanic manifestations but the powerful depressing effect of these salts made it evident that they were not so well suited for the suppression of tetany. Moreover it was observed that similar amounts of sodium chloride or bicarbonate potassium chloride and ammonium chloride had no curative action on the contrary sodium bicarbonate seemed rather to aggravate the symptoms. Later Joseph and Melzer found that an intravenous injection of hypertonic (10 per cent) NaCl solution had a beneficial effect on tetanic dogs. Obviously the action of the hypertonic salt solution was not due to the NaCl *per se* but rather to the high osmotic pressure of the solution, an explanation which is furthermore supported by the observation that hypertonic solutions of glucose also slowly relieve the muscular twitchings. Recently Wilson, Stearns and Janney reported that an intravenous injection of dilute hydrochloric acid has the same effect on the tetanic dogs as an injection of calcium. The observations of MacCallum and Voegtlin on the aggravating effect of  $\text{Na}_2\text{CO}_3$  are confirmed and extended. Hence it is evident that a number of inorganic salts (Ca, Sr, Mg) and hydrochloric acid all possess the property of temporarily curing tetany. None of these agents, however, is capable of saving the life of parathyroidectomized animals, although animals treated in this manner may survive untreated controls.

MacCallum and Voegtlin on the basis of their results formulated the hypothesis that the parathyroid controls in some way calcium metabolism, that after the removal of this gland the body fluids and soft tissues are deprived of soluble calcium, hence the appearance of the abnormal irritability of the nervous system with all the typical symptoms of

tetany. This hypothesis seems especially reasonable, if considered in connection with the splendid researches of Erdheim who was able to demonstrate that parathyroid insufficiency is accompanied by a lack of calcification of the teeth of rats. Temporary insufficiency of the parathyroid became noticeable in the teeth of rats in the form of a zone of deficient calcification if the dentin preceded and followed by a normal layer of dentin. MacCallum and Voegtlin also were able to demonstrate a loss of calcium salts in the urine and faeces of parathyroidectomized animals. The blood and brain calcium was also found to be reduced below normal. Later work by MacCallum, Lambert, and Vogel yielded additional proof to the calcium deficiency theory of tetany. It was shown that if calcium free blood is perfused through the leg of a normal dog the irritability of the nerves supplying the leg increases markedly. Blood obtained from a dog in tetany has the same effect on the other hand normal blood perfused through the leg of a tetany dog brings back to normal the abnormal irritability of the peripheral nerves. The injection into animal of substances such as oxalates which precipitate calcium from its solution causes fibrillary twitchings and various other signs of hyperexcitability this also speaks in favor of the calcium deficiency theory.

The fact that HCl is as efficient as calcium in the treatment of experimental tetany would seem at first consideration to contradict the whole hypothesis. It should be remembered however that hydrochloric acid is a solvent for certain insoluble calcium compounds. Furthermore it has been shown that the calcium of the blood is partly combined with proteins and other colloids and would under these conditions not be fully available to exert all its physiological actions. One might easily conceive that the introduction of hydrochloric acid directly into the blood would increase temporarily at least the hydrogen ion concentration of the blood and in this way dissociate complex calcium compounds. The calcium set free would then become available for needy tissues such as the nervous system in tetany. In other words the treatment with acid might result in a liberation of

soluble calcium from some parts of the body followed by its redistribution.

This conception would however obviously not be satisfactory to explain the beneficial effect of hypertonic solutions of sodium chloride and glucose. In this case the proper explanation might be as follows. Hypertonic solutions of NaCl and glucose are known to depress the activity of certain tissues. Recently I myself observed the marked depressing effect of hypertonic NaCl on the tonus of the smooth muscle of the uterus. Drying out of nerves is known to decrease their irritability. The injection of hypertonic solutions in tetany might, therefore, produce the disappearance of the symptoms by withdrawing by osmosis water from the tissues. Thus a considerable amount of tissue water is lost after an injection of hypertonic salt solution into tetany dogs. A marked diuresis sets in immediately after the injection is completed.

On the basis of these considerations it would seem fairly well established that calcium is intimately connected with the etiology of parathyroid tetany.

It is, however difficult to explain why the continued administration of calcium salts does not save the life of parathyroidectomized animals. In this connection I should like to call attention to the possibility that after all tetany may represent but a symptom complex which may be very well controlled by calcium salts but is not necessarily the entire expression of the abnormality of the body following parathyroidectomy. Tetany is so to speak only one part of this pathological condition. It is highly probable that in the absence of the parathyroid the metabolism of the body and the properties of the cells are more or less altered.

Thus Wilson, Stearns, Thurlow and Janney have recently discovered that complete parathyroidectomy in dogs is very soon followed by an alkalosis of the blood. The blood becomes more alkaline and the kidney excretes less acids and ammonia. With the development of tetany however the elimination of acids and ammonia increases, this being accompanied by an acidosis of the blood and an increased hydrogen-ion concentration of the urine. Evidently some of the biochemical properties of the blood and probably also of the tissues are different during the periods of muscular hyperactivity and during the

period of depression. The obvious difference in the behavior of the animal in the stage of active tetany (muscular twitchings, tachycardia etc.) from that of depression following the active stage, therefore finds also an expression in the biochemical composition of the blood, the first stage being characterized by an alkalosis, the latter representing an acidosis. The slight increase in the hydroxyl ion concentration in the blood after parathyroidectomy might possibly be one of the factors concerned in the withdrawal of soluble calcium salts from the blood inasmuch as an increase of hydroxyl ions would tend to precipitate soluble calcium salts. On the other hand one might look upon the increased muscular activity during an attack of tetany as causing an increased production of acid products (lactic acid<sup>1</sup>) with the result of increasing the hydrogen ion concentration of the blood which in turn might lead to a mobilization of more or less insoluble calcium compounds contained in the blood and tissues. Viewed in this light the temporary recovery from an attack of tetany which is such a common observation in experimental tetany might perhaps find its explanation.

The metabolism in tetany is also abnormal in other respects. Greenwald calls particular attention to the reduction in the excretion of urinary phosphates and their retention in the blood. Koch notes the excretion of methyl guanidine, choline, and beta aminazolyethylene in the urine during tetany. This last mentioned substance was suggested by Biedl as possibly representing the hypothetical tetany poison, an assumption which seems to the author to be rather doubtful. These toxic bases are normal metabolism products and a slight increase in their excretion with the urine during tetany might be due to the overactivity of the muscles in this condition. Lactic acid also appears during tetany in the blood and urine and the urinary creatine is increased. These substances are known to be intimately connected with muscular activity. Furthermore the toxic symptoms of these bases differ in many respects from those characteristic of tetany.

The accompanying table includes in a summary way the various metabolic changes following parathyroidectomy.

In summing up our present knowledge of the nature of tetany, the calcium deficiency hypothesis first advanced by MacCallum and Voegtlin still seems to explain all of the

<sup>1</sup>MacCallum and Voegtlin observed the presence of lactic acid in the blood of dogs in tetany and Cooke demonstrated the presence of this substance in the urine of such animals.

#### METABOLIC CHANGES FOLLOWING PARATHYROIDECTOMY IN DOGS

	Pre-tetany Stage	Active Tetany
Total nitrogen metabolism	Normal	Increased
Urinary ammonia	Normal	Increased
Blood ammonia	Normal	Increased
Urinary creatinine	Normal	Increased
Urinary creatine	Normal	Increased
Urinary phosphates	Decreased	Increased
Blood phosphorus	Decreased	
Urinary sulphates and neutral sulphur	Normal	Increased
Urinary total nitrogen	Normal	Increased
Urinary toxic bases		Present
Urinary lactic acid	Absent	Present
Blood lactic acid	Absent	Present
Urinary Ca and Mg	Increased	Increased
Blood calcium		Decreased

experimental facts. Briefly stated tetany is due to a withdrawal of soluble and physiologically available calcium salts from the blood and especially the nervous system. This being followed by an increase in the irritability of the nerves and secondarily the skeletal muscles.

Tetany is but one expression of the reaction of the body to the complete removal of the parathyroid gland. It is quite probable that the gland has other functions besides its influence on calcium metabolism. Further studies especially of the period immediately following parathyroidectomy and preceding active tetany should be undertaken in order to throw more light on this problem.

#### TREATMENT OF TETANY

Three methods of treatment of tetany are at present available:

1. *Calcium therapy.* Intravenous injections of 4 to 5 per cent calcium lactate or chloride almost instantly remove the hyperexcitability of the nervous system, the muscular twitchings, the tachycardia, and the tachypnoea and the animal is greatly relieved of pain. Oral administration of calcium salts is of doubtful value. Intramuscular and subcutaneous injections are followed by intense local irritation and are, therefore, contra-indicated. The intravenous injection should be slow and continued until the desired effect is produced, which will require different amounts of calcium in each case.

The same holds true for the treatment of tetany in the human. The beneficial effect



of this treatment usually lasts for 24 hours or longer when symptom of excitation begin to reappear. The life of the animals cannot be saved by the continued calcium administration and the animal usually dies with evident symptoms of cachexia and depression. The calcium treatment is, however, of value in the control of a rude and temporary tetany.

2 *Treatment with parathyroid extract* Vassale, MacCallum, Beebe and others have observed that the injection of the fresh extract of the fresh parathyroid (preferably from cattle) is followed by a temporary relief of the animal from tetany. Feeding the gland has no influence on tetany.

Beebe claims that the active substance is precipitated with the nucleoprotein of the gland. This treatment is naturally troublesome, as the necessary material is not always easily available.

3 *Transplantation of parathyroid* Halsted has shown conclusively that autotransplantation of the parathyroid gland is feasible provided that there is in the subject a demand for such tissue (partial or complete insufficiency). The gland can be implanted into the abdominal muscles and begins to function normally within a short time. According to Halsted isotransplantations are never successful as the transplanted glands are absorbed. Other authors, however, claim to have succeeded in transplanting parathyroids from one individual to another.

#### TETANY DURING PREGNANCY AND LACTATION

In rare cases tetany has been observed in the human during pregnancy and lactation. According to Seitz tetany is usually confined to pregnancy about 90 per cent of the cases occurring during pregnancy and only 10 per cent during lactation. Experimentally this subject has been approached by a number of investigators. As early as 1808 Vassale and Generali reported tetany during the first days of lactation in a bitch 18 months after extirpation of three parathyroids. The animal was to all outward appearance normal after the operation, but developed a most severe attack of tetany a few days after she had given birth to her young. The experiments of Thaler and Adler are of especial

interest in this connection. They succeeded in producing tetany in rats during pregnancy by partial parathyroidectomy. However tetany was never observed in these animals during lactation. Successive pregnancies always caused the reappearance of tetany so that we may regard this condition as an example of latent tetany.

Gross observed tetany in a pregnant cat after extirpation of three parathyroids. The animal appeared to be normal for 25 days after the operation when suddenly tetany set in. Twelve days later the cat gave birth to three young and the symptoms disappeared.

Similar observations were made by Erdheim, Fromme and others. Thierry and Knoll, at the suggestion of Seitz, studied the response to galvanic stimulation in pregnant women and found high values in 80 per cent of their cases (120). The nerve irritability seemed to increase as pregnancy advanced and reached its highest point at the time of delivery. Then normal irritability was soon re-established. Similar observations on animals are lacking although it would be of interest to ascertain the changes in nervous irritability during reproduction in partially parathyroidectomized animals. Fromme was able to show that the injection of extracts of placenta into partially parathyroidectomized animals caused tetany. This does not necessarily mean that the placenta is the etiologic factor in tetany during pregnancy as Rudinger was able to elicit tetany in partially parathyroidectomized rats by the injection of tuberculin, morphine, atropine, and substances.

Whether or not calcium has any relation to tetany in pregnancy is difficult to decide. The daily calcium requirement of the fetus is relatively small in comparison to that contained in the average mixed diet. It might, however, be conceivable that when the calcium intake with the food is relatively low a deficiency of calcium in the tissues and blood might follow which might be aggravated by an existing parathyroid insufficiency. The same would hold true for tetany during lactation. We are forced to look upon pregnancy as a condition which puts an extra strain on

the physiological processes of the body. Under these circumstances it is rather surprising that tetany is not a more frequent occurrence during pregnancy in the human. Diseases such as beriberi and pellagra are especially common during the period immediately preceding and following childbirth. Incidentally it may be stated that pregnancy is not associated with any morphological changes in the parathyroid gland.

The experimental data seem to point to the fact that interruption of pregnancy and lactation soon removes the symptoms of tetany.

#### TETANY IN OFFSPRING OF PARATHYROIDECTOMIZED MOTHERS

Iselin made the interesting observation that rats born of partially parathyroidectomized mothers exhibited an abnormally high electrical irritability. Furthermore these animals seem to be especially susceptible to the effects of parathyroidectomy, inasmuch as they died 4 to 10 hours after such an operation with most intense symptoms of tetany.

#### ECLAMPSIA AND THE PARATHYROID

Vassale on the basis of his experiments with parathyroidectomized animals advanced the theory that eclampsia is tetany modified to some extent by pregnancy. According to Vassale eclampsia is due to a hypoparathyroidism. However it should be emphasized that the clinical pictures of tetany and eclampsia differ in so many essentials that the hypothesis does not seem to be reasonable. Furthermore it was shown by Seitz that the increased irritability of the peripheral nerves to galvanic stimulation a typical and constant symptom of tetany is not constantly present in eclampsia.

#### SUMMARY

1. The parathyroid gland has a definite physiological function which is still incompletely understood.
2. The presence of a minimum of parathyroid tissue in the body is essential for life and the continuation of normal metabolism.
3. Parathyroid insufficiency seems to be characterized by an increased irritability of

the nervous system to the galvanic current which may be due to the withdrawal of soluble calcium salts from the blood and tissues. Parathyroid insufficiency leads to an alkalosis which is converted into an acidosis as a result of active tetany. Definite metabolic changes take place in animals after complete parathyroidectomy.

4. Pregnancy puts an extra strain on the functions of the parathyroid as evidenced by the appearance of tetany during this period in partially parathyroidectomized animals.

5. Tetany has been observed during lactation in animals with parathyroid insufficiency. Interruption of lactation was followed by recovery.

6. The offspring of partially parathyroidectomized animals exhibit a marked increase in nerve irritability.

7. An intravenous injection of soluble calcium or strontium salts or hydrochloric acid almost instantly removes the symptoms of tetany. However tetany may reappear after this treatment and the life of such animals cannot be saved by the continued administration of calcium. The injection of parathyroid extract seems to have a temporary curative effect on tetany animals.

Isotransplantation of parathyroids into animals with parathyroid insufficiency is usually successful.

The spontaneous recovery from tetany in experimental animals is probably due to changes in their metabolism (acidosis) caused by the hyperactivity of the skeletal muscles during tetany.

8. The experimental facts do not support the theory that eclampsia is due to hypoparathyroidism.

9. A condition which might justly be termed hyperparathyroidism is unknown at the present time.

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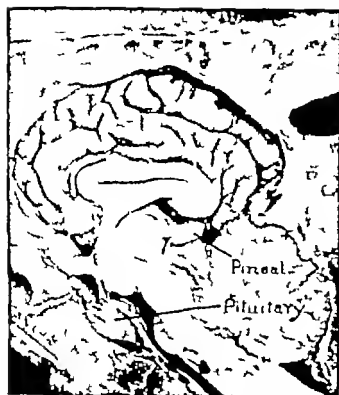


Fig. Sagittal section of beef brain showing size, position, and relation of pineal gland.

muscle fibers in the pineal are without significance to pineal function. (3) Nerve fibers and neuralgia are to be found at least in certain animals, but these are probably of trivial import. (4) The gland undergoes involution changes, beginning in the human as early as the seventh year. Involution is pronounced at puberty. The degeneration is, however, not complete and the histologic picture of the adult gland is not such as to remove the possibility of a continued function in adult life.

*Pineal neoplasms and resulting functional disturbances.* Tumors of the pineal are not of frequent occurrence. The total number of authentic cases with subsequent necropsy findings in some is not more than 70. These cases have been the source of the greatest information as to the functions of the pineal. In 1898 Heubner described a boy of 4½ years who showed a precocious sexual and somatic growth. The body of this boy was that of a boy of 8 or 9 years. The genitalia corresponded to the proportions found at puberty. The pubic hair was 1 centimeter long. A year later at autopsy a teratoma of the pineal

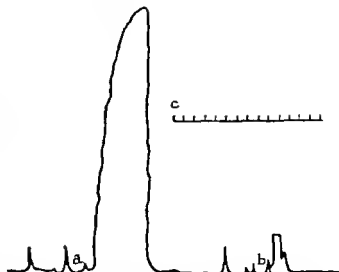


Fig. 2. A comparison of the effect on surviving guinea pig uterus of pituitary and placental gland extracts. The height of contraction from the placental extract administered at *b* is trivial in comparison with the contraction at *a* induced by the much smaller quantity of pituitary extract. Time—minutes.

was demonstrated. By 1907 Marburg was able to collect 40 histories of such types. He sought to establish a clinical entity for pineal dysfunction. The term *macrogenitosomia praecox* has subsequently designated this condition. In a more recent paper Marburg attributes to the condition the following characteristics:

1. General. These include all the usual signs of intracranial pressure usually secondary to a subsequent internal hydrocephalus.

2. Neighborhood. These for the most part are dependent upon encroachment upon the quadrigeminate bodies, leading to diverse oculomotor paralyses and pupillary disturbances and encroachment upon the cerebellum with ataxic manifestations.

3. Constitutional. Under this designation are grouped the manifestations attributable to the derangement of the pineal glandular function. This constitutional syndrome consists of first, early sexual maturity, evidenced in the enlarged sex organs, pubic hair, general body hair, early change in voice; second, precocious mental development, evidenced in the maturity of thought and speech; third, general body overgrowth to the extent that a child of 5 or 6 years may have the appearance of a child 11 or 12.

Frankl-Hochwart similarly has summed up the characteristics of this pathologic state.



Fig. 1. Result of feeding pineal gland extract young guinea pigs of the same age. A mal (left) controls. Animals to right, 1, need fed.

He states: "When one finds in a very young individual along with the general symptoms of tumor as well as the signs of a lesion of the corpora quadrigemina, abnormal body growth, unusual growth of hair, adiposity, somnolence, premature genital and sexual development, and finally intellectual maturity, one must think of pineal tumor."

Of the 70 cases at the present time available in the literature only 25 occurred prior to puberty. Because of the pineal involution that occurs by the time of puberty, only in these 25 cases are constitutional manifestations to be anticipated. It is significant that with two exceptions all cases occurred in boys.

Many cases of pineal tumors before puberty manifest none of the signs of precocity of development that are so striking in a few selected cases. A study of the clinical material reveals how little consideration has been given to the possibility of pluriglandular involvement in fact in some early cases the necropsy demonstration of a pineal tumor led to the association of all prior metabolic changes to pineal functional perversion. This grew out of the prevalent conception of each endocrine gland as an entity entering into no interrelations with other similar organs.

Judging these cases in the light of recent advances in pituitary pathology and physiology, it is difficult to delineate the manifestations of pure pineal derangement from a pluriglandular condition. Cushing has pointed out that from the intracranial alterations attending pineal neoplasms, the hypophyseal functions are readily deflected from the normal.

This infrequent condition in which growth and differentiation into the adult is so deviated from the normal that very young children acquire in part the sexual, mental and somatic characteristics of maturity has naturally led to diverse attempts to induce such a condition experimentally. Through the extirpation of the pineal, through the feeding of pineal substances to young animals, through the intravenous and subcutaneous administrations of pineal extracts, has information been sought as to the significance of this organ in the body's economy. The outcome of such investigations are described in subsequent paragraphs.

*Extirpation of the pineal gland.* Situated near the center of the brain, the inaccessibility of the pineal has prevented any widespread use of this method. The trauma is necessarily severe and until the recent reports

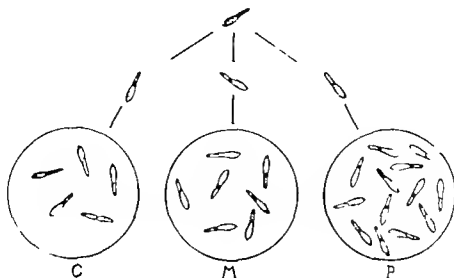


Fig. 4. A diagram showing the modified division rates of paramoecia (starting with a single paramoecium) *P* 0.05 per cent pineal extract in hay infusion. *M* 0.05 per cent muscle extract in hay infusion. *C* hay infusion alone. Diagram represents the average of thirty-six observations.

by Dandy (1915) and Horrax (1916) the mortality has been very high—75 deaths out of 95 operations in one series, and 12 deaths out of 15 operations in another. With so high a mortality it may be questioned whether the few survivors would exhibit constant changes referable to pineal deprivation. The mortality is usually due to hemorrhage into the ventricle from injury to the central cerebral veins, or to direct injury to the quadrigeminate bodies or adjacent brain tissues. Dandy has recently developed an operative procedure whereby much of the trauma is obviated. The essential innovation lies in an approach through section of the splenium of the corpus callosum thus permitting freer manipulations in the operating field. Although the mortality may thus be reduced the results obtained by Dandy on comparison with those obtained more recently by Horrax, are uniformly dissimilar. The respective summaries of these two investigators quoted below indicate how incomplete are our available data bearing upon extirpation as a method of approach to the problems of pineal function. Dandy states:

Following the removal of the pineal I have observed no sexual precocity or indolence, no adiposity, emaciation, no somatic or mental precocity or retardation.

2. Our experiments seem to yield nothing to sustain the view that the pineal gland has any active endocrine function of importance either in the very young or adult dogs.
3. The pineal is apparently not essential to life and seems to have no influence upon the animal's well being.

These negative findings are in keeping with the earlier work of Exner and Boese, and Biedl. Subsequent to Dandy's publication an extended report has been made by Horrax, whose positive findings are in keeping with those of Foa and Sarteschi. Horrax states:

1. Total experimental pinealectomy is possible in guinea pigs and rats.
2. Pinealectomized male guinea pigs show a hastened development of the sexual organs manifested before maturity by a relative increase in size and weight, both of the testes and seminal vesicles over control pigs of the same litter.
3. Histologically, the testes and seminal vesicles of these animals if taken before the age of sexual maturity show a more advanced physiological state than their controls.
4. The pinealectomized females appear to show a tendency to breed earlier than controls of the same age and weight.
5. For several reasons, young rats are likely to prove better subjects for experimental pinealectomy than young guinea pigs, and some evidence of hastened maturity has been obtained in this species.

*Immediate results following the intravenous or subcutaneous administration of pineal extracts.* Unlike the intense cardiovascular action of suprarenal extracts, or the uterine

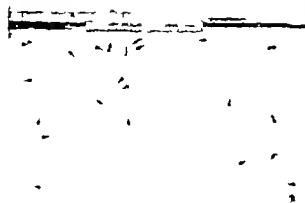


FIG. 1. Comparison of 1 group of larval tadpoles taken from the same lot photographed simultaneously after 1 week of laboratory feeding (group below fed small amount of deactivated pineal gland 1 week). Group box fed eq. with amount of deactivated material

contracting action of pituitary extracts the immediate result from intravenous or hypodermic injections of pineal extracts are not pronounced. Such phenomena as decrease in arterial tension dilatation of the blood vessels, altered amplitude and rate of the heart beat diuresis glycosuria, and uterine contractions have been reported and confirmed. Under experimental conditions the contraction produced in the uterus by 1 cubic centimeter of 20 per cent pineal extract is much less intense than the contraction produced by 1-200 cubic centimeters of 20 per cent pituitary extract (Fig. 2). The intensity of these several activities is so slight that at the present time only technical importance may be attached to these findings.

*Feeding experiments with pineal glands.* The syndrome of precocious development seen in the human is usually interpreted as the outgrowth of pineal deficiency—a hypopinealism. Such being the case, if the feeding of pineal materials determined any changes, a state just opposite that cited above would be

anticipated—a condition of deferred sexual, mental and somatic maturity. Curious to record feeding experiments lead to rapid sexual and somatic development.

Dana and Berkeley fed pineal material to young animals (4 terms rabbit guinea pig) and noted 5 per cent increase in weight over controls. These investigators sought to determine the extent of stimulating influence upon children of low mental ability. Fifty feeble minded children were treated and suitably controlled with other children of the same age and diagnosis. Binet tests are the criteria of mental advancement. Psychological changes resulted, but prolonged treatment the mental development is greater than that prior to treatment and in excess of control children of the same mental age. These studies on feeble minded children afford certain technical evidences of value but the quantity of improvement resulting is not sufficient to warrant widespread use of pineal material in prophylactic treatment of feeble mindedness.

Huskins (1916) in feeding experiment upon albino rats, studied the influence upon the growth of the anterior pituitary gland excluding the rostral thymus, hypophysis, and pituitary stalk could indicate that none of these glands has a constant effect upon the growth-rate of young rat.

McConnell (1914-1915) employed 400 young animals (chickens guinea pigs) during experiment to establish the extent of influence the pineal exert upon growth and development. He concludes from his experiments that the same period of development usually attributed to pineal deficiency (hypopinealism) as obtained in animals supplied not an increased amount of pineal substance by feeding of pineal preparations. Such administration of pineal substances led to more rapid growth of body than normal and determined early sexual maturity. The excess in rate of growth most pronounced 4-6 per cent excess in eleven weeks using animals fed pineal tissue obtained from young animals. A tendency to gigantism has followed pineal administration after maximum size attained pineal administration appeared to be ineffective. Both males and females respond to the influence of pineal substances in rate of growth but the response has been more definitely manifested in males.

## II THE INFLUENCE OF THE PINEAL GLAND UPON GROWTH AND DIFFERENTIATION. A RECORD OF EXPERIMENTS UPON POSTNATAL AND EMBRYONIC GROWTH DIFFERENTIATION PROCESSES

In the developmental processes inaugurated at conception two distinct phases are to be observed—growth and differentiation. In intra uterine life differentiation into specific organs and tissues is the essential process. In pre-adult life, growth processes are dominant. At puberty differentiation again asserts its influence. In adult years both these developmental processes are less in evidence, a condition we commonly designate as maturity.

These two phases of development are neces-

sarily intricately interrelated but within certain limitations may be separately altered. Traces of thyroid tissue added to the water in which tadpoles live will bring about the complete transformation of the tadpole into a miniature frog within one week whereas normally this metamorphosis consumes from 4 to 6 months (Gudernatsch). This phenomenon is due to the intense differentiative action of the thyroid. Similarly thymus tissue retards differentiation of tadpoles. At the period of development wherein normally tadpoles begin to differentiate, thymus fed tadpoles continue to grow larger without differentiation. Manifestly both these factors in development are ultimately dependent upon the quantity or quality of cell activity.

In our earlier records of the influence exerted by the pineal upon development we employed young animals and chicks. Variations were introduced to reduce the possibility of incidental error in dosage in method of administration in source of materials, in age of the test animals. With the exception of two series we have uniformly found that young animals who had been fed (or injected) pineal materials have outgrown their controls of the same age (Fig. 3). In one series the difference was 40 per cent at 11 weeks of age. No tendency to gigantism was observed. As the normal adult size was approached the stimulative action of the pineal was no longer effective. The testes of certain of these rapidly developed guinea pigs were examined in comparison with controls. Grossly the testes from pineal fed animals were 50 per cent larger. Microscopically the cellular elements were far in advance of controls and were characterized by very active spermatogenesis. The females gave birth to young when the controls were in the middle third of their gestation. At first it was thought this might be evidence of a shortened gestation period but more carefully scrutinized experiments determined that this was the outcome of earlier breeding due to an earlier maturity.

At all times this type of feeding experiment is open to the error that normally such animals exhibit very appreciable individual variations. We have anticipated that less

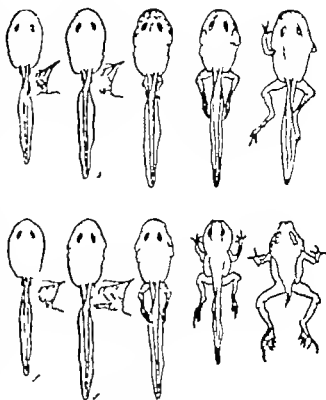


Fig. 6 Drawings made at weekly intervals indicating the rate of metamorphosis of *Bufo Americana* tadpoles fed pineal tissue in comparison with normal metamorphosis. To *e* inclusive controls; *f* to *j* pineal fed. The small figures to the right of *a*, *b*, *f*, and *g* represent stages in the development of the hind legs for these respective tadpoles.

complex life forms that show scant individual variations, even in large numbers would afford acceptable data as to any action that pineal extracts might have on their growth differentiation processes. For the purpose, we selected (1) *paramecia* (*paramecium caudatum*) a unicellular organism that through transverse fission may divide into many generations in a single day (2) tadpoles of frogs and toads. This larval form of the frog and toad corresponds in many respects to embryonic intra uterine life in higher animal life.

***Paramecium experiments.*** Cultures were maintained in the laboratory growing on hay infusions. These organisms are about  $\frac{1}{4}$  millimeter in length and may be readily counted with the naked eye. Through transverse splitting reproduction is accomplished. Under standardized conditions the rate of divisions is relatively constant. It will be argued that in the event of constant exceptional variations in the number of generations formed when pineal materials were added to the culture medium and not occurring when other similar protein materials were introduced that the phenomenon is attributable to pineal activity. The following procedures were employed. A single para-



ma am as had t t t he n produ in d the th d  
 gen tion These sulting n nd idual n separ at  
 ed nd placed i th t m t t one ha n dion (b)  
 on hay fuson ed t d h ted, n d gland  
 o g ent t th ( ) hay fuson tract of  
 d d t t m d h d h ont d material  
 (d) the fourth n d d n d d These ult res  
 m t n f m d h d d d d d d d d  
 (4) d d d d d d d d d d d d d d d d d d  
 l res ere s m t t h n d d d d d d d d d d  
 M n d d d d d d d d d d d d d d d d d d  
 the p n e l t t t t t t t t t t t t t t t t t t  
 y m t t n d d d d d d d d d d d d d d d d d d  
 fuson p d d d d d d d d d d d d d d d d d d  
 s g on n d d d d d d d d d d d d d d d d d d  
 m d e t d d s t t t t t t t t t t t t t t t t t t  
 s t

photograph d actual measurement the variations  
 ere noted

The present paper can make but most casual reference to the accumulated results. The phot graph and drawing will serve to indicate the trend of results (Fig 5) (Type photograph a latent trays of pineal gland and muscle fed tadpoles of the same laying) At this stage the pineal fed while about double the size of the control sh w no tendency to differentiation Ultimately however differentiation earlier a may be observed in the drawing of Fig 6

It is our belief that the pineal gland contain some substance capable of stimulating growth and ultimately differentiation in these larval form

TABLE I - REPRODUCTION OF PARAMECIA

No. of larvae	Time (min)			Time (min)		
	1	2	3	4	5	6
3			1		1	1
4	5	4			1	5
5		4			1	8
		5			1	6
8	4			1	4	7
9	5		0	5	0	9
	1		4	4	4	1
			4	4	4	1
1	3	4	0	10	1	4
4				1	5	6
5		5	1			
6		10				
7	1	2				
1	4			5		4 0

The inference is, that pineal material when added to the culture medium of the unfed larva promotes a more rapid rate of reproduction (Fig 4)

**Tadpole per m t.** The time of appearance of the necessary stages in the differentiation of tadpoles to frogs an excellent criterion of the influence of an agent on the living conditions of these animals. For the final stages of simple laying fairly on land is the occurrence of such stages: the budding of the hind legs, the subsequent formation of the different portions of the hind legs, the closing of the gills, the vision of the fore legs, the assumption of terrestrial life. Such are the phenomena brought to light by the production of pineal gland material into the living body of the tadpoles.

About 50,000 frog eggs are procured and hatched in the laboratory. These are divided into colonies of about 200 each. In most cases these colonies are from the same laying. With so abundant material it was possible to produce like variations of test materials and controls. The pineal glands were fractionated into various components and tested against controls such as other endocrine glands, split proteins, histamine, polio, etc. Through

#### CENTRAL SUMMARY

From the lack of unanimity in the literature any conclusion as to the detail of pineal gland function must be made flexible rather than dogmatic. A survey of available data lead to the following summary: a representation of the present status of the pineal as an organ of internal secretion.

(1) A clinical syndrome is to be associated with disturbances of the function of the pineal gland. Because of the involution of the pineal at puberty the constitutional manifestation of pineal pathology appear to be confined to prepubertal years. The essential characteristics (apart from precocious and neighborhood manifestations) are: (a) early sexual development evidenced in the enlarged genitalia, pubic hair, general body hair, early change in voice; (b) precocious mental development manifested in maturity of thought and speech; (c) general overgrowth of body to the extent that a child of 6 or 7 years may have the appearance of a child near puberty.

(2) The experimental extirpation of the pineal gland is surgically possible. The gland is not essential for the maintenance of life. The early symptoms following pinealectomy are attributable to the severe brain injury. No changes attend the removal of the gland in adult animals. As to the effects of pinealectomy in young animals, Sarteschi, Foa, and Horrax respectively state that the

removal of the gland lead to precocity of development Exner and Boese and Dandy report no changes after pinealectomy

3 The administration of pineal substance to young mammals is reported to hasten growth and sexual maturity In unicellular organisms (paramoecia) pineal extracts increase the rate of reproduction to more than double that of controls In larval forms (ranidae) both growth and differentiation are hastened as a result of pineal feeding

4 The inference is allowable that the pineal gland is an organ of internal secretion whose functions, however are of minor significance in the general activities of the endocrinous system

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## THE RELATION OF THE PARATHYROID SYSTEM TO THE FEMALE GENITAL APPARATUS

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THE parathyroid glands were first described in 1880 by Sandström but no physiological significance was attached to these bodies until 1891 when Gley demonstrated their relationship to tetany. From that time extensive experimental and anatomical studies have been carried on and it has been shown that the parathyroids are specific organs with internal secretion.

The paramount interest in the parathyroids has been dependent upon the occurrence of tetany as the result of the removal of these bodies in guinea operations. However the technique of partial thyroidectomy as now practiced is so planned as to safeguard the parathyroids consequently tetany is a rare sequel to the operation.

### ANATOMY

The parathyroid glands (Sandström) or "epithelial bodies" (Kohn) are branchial cleft derivatives. They develop from the third and fourth branchial clefts of each side as masses of compact epithelial cells. The glands are arranged in pairs, a superior and an inferior body being present on each side. They lie close to the posterior surface of the thyroid in the majority of instances external to the surgical capsule. The bodies vary in size from about 3 to 15 millimeters (Figs. 1, 2, 3).

The blood supply of the parathyroids is derived from the most part from the inferior

thyroid artery. After ligation of this vessel, the parathyroid of the same side may be supplied with blood from the superior thyroid artery and after ligation of the superior and inferior thyroid arteries of one side the parathyroid of that side may be supplied, through anastomoses, by the vessels of the opposite side as well as by the pharyngeal, esophageal and tracheal vessels.

Nerve fibers, presumably from the sympathetic, have been demonstrated by Rhinehart in close relation with the vessels of the parathyroid. Since he found no fibers within the parenchyma he assumed that these were vasomotor and not secretory nerves.

A sensory organs that is small suprarenal glands have been found not infrequently in various positions in the neck but especially below the thyroid within the thymus and even within the thyroid.

### PHYSIOLOGY

That there is a correlation between the functions of the various glands of internal secretion is now generally believed but in what manner and to what extent the parathyroid bodies affect and are affected by the thymus, thyroid, pituitary, adrenals and pancreas is hypothetical. The immediate object of this paper is the question of possible interaction between the parathyroids and the generative organs. The consideration of this feature will be deferred.

The function of the parathyroids is un-

known hypotheses as to their physiology are for the most part founded upon the relationship of the parathyroids to tetany. A vast amount of experimental work has been done in this connection the results indicate that complete removal of parathyroid tissue results in fatal tetany.

After partial removal of the epithelial bodies relative insufficiency of the parathyroid function — latent tetany — may occur. Under such conditions tetanic attacks may be precipitated in an apparently healthy animal by circumstances favorable to its development such as pregnancy and lactation. This feature is important in the consideration of the correlation between the parathyroids and the generative organs. It will, therefore be elaborated later.

Certain extraneous influences also affect the development of tetany. Thus a meat diet or a cold environment appear to intensify the manifestations of tetany.

*The pathogenesis of tetany.* The hypothesis has been advanced by MacCallum. Frommer, Lundborg, Vassale, Pineles and others that the parathyroids have an antitoxic action the suppression of which results in the tetany reaction. By this hypothesis tetany parathyreopriva would be explained as an auto-intoxication and one perhaps the chief function of the parathyroids would be the prevention of the action of certain toxic substances regularly present in the circulation.

MacCallum inclines to the belief that tetany is closely dependent upon a disturbance of the calcium content of the blood. He states that direct analysis of the blood of an animal in tetany shows it to be very poor in calcium. However Cooke and others have questioned the importance of the calcium decrease in tetany.

As a result of the fact that in tetany parathyreopriva bases seem to be eliminated more freely and stored in less amount than under normal conditions the hypothesis has been advanced that the condition is an evidence of acidosis (Morel, Musser). Experimental work which is now in progress convinces me that acidosis in tetany is absent or not striking.

No constant lesions have been demonstrated

in the nervous system in tetany although much work has been done upon this phase of the subject.

*Relation of the parathyroids to tetany in man.* That tetany following goiter operations is usually due to the removal of the parathyroid glandules has been proved by a long series of careful experiments upon animals as well as by significant findings of Erdheim, Pineles and others in man. However occasionally tetany has occurred after comparatively slight interference with the thyroid such as enucleations the removal of one lateral lobe and vascular ligations (Iversen). That a light tetany can develop when the four arteries are ligated is readily understood but the fact that tetany occurs only rarely as a result of this procedure is surprising (Iversen).

How many parathyroids can support health with no evidence of parathyroid deficiency cannot be positively stated but the best evidence indicates that two parathyroids are essential and sufficient.

It follows from an analysis of the reported cases that the occurrence intensity and course of postoperative tetany in man are dependent upon the amount and functional usefulness of the parathyroid tissue that is left (Guleke).

#### SYMPTOMS

The symptom complex of tetany was first described by Steinheim in 1830 and the name tetany was subsequently suggested by Corvisart. Since then the same clinical picture has been repeatedly noted in association with various conditions of widely different character. For example it has been seen to occur with severe gastro-intestinal affections especially dilatation of the stomach with pregnancy and the puerperal state with some acute fevers with various nervous diseases and after removal of the thyroid gland. The cause of its occurrence in most of these conditions is not understood but as a sequel to thyroid operations tetany has been shown to depend upon deficiency of functioning parathyroid tissue and in consequence has been designated by Erdheim tetania parathyreopriva. The clinical manifestations of this type of tetany are the best understood

and must be taken as the standard. We will therefore outline them briefly.

Tetania or tetany parathyreopriva is characterized by certain very striking symptoms which render it practically unmistakable. The most conspicuous of these are intermittent tonic spasm of the voluntary muscles, those of the extremities being most affected. A salient feature is the *exclusive involvement of the flexor groups of muscles*. Intercurrent contractures of the facial muscles are relatively rare, and the muscles of the chest, back, and abdomen participate in exceptional cases only. The tetanic spasms are usually preceded by certain prodromata which persist for a variable period before the onset of the attack. These include headache, sensation of weakness or prostration, more or less rigidity of the limbs, radiating pains, and clonic twitching. The contractions usually begin in the hands and subsequently involve the feet; less often the feet are affected coincidentally or independently. The spasms are almost always, although not invariably, symmetrical and bilateral. As a rule, two or more of the fingers are flexed and the thumbs are forcibly adducted, sometimes tightly clasped by the contracting digits. The most characteristic contraction has been designated *accoucheur's hand* (Trousseau) (Fig. 5, Fig. 7). In 50 per cent of the cases the wrist also becomes flexed while flexion of the forearm with adduction of the arm to the trunk occurs infrequently. Exceptionally, the fingers are held wide apart, the terminal phalanges alone being flexed. The feet when involved take the position of pes equinus or equinovarus as a result of contraction of the muscles of the calf. In the contractions of tetany the affected muscles become very hard to the touch and oppose a powerful resistance to attempts at passive relaxation. Should this prove successful the tetanic attitude is at once resumed when the traction diminishes. Fibrillary twitchings are sometimes visible in the contracted muscles.

The onset of an attack is as a rule about one to three days after the operation, but this period may be less; in rare cases it may be as long as two weeks. The duration of an

attack may not exceed a few minutes, or the attack may last for a number of hours but it rarely persists as long as 48 hours. The termination of a tetanic spasm is frequently preceded by symptoms resembling those observed at the onset.

While there may be a free interval of days or weeks between the attacks unfortunately this is far from being the rule. There are generally several attacks in the course of the day, the patient's rest at night being unbroken. In the severest cases one attack follows another with alarming rapidity. As a rule, consciousness is retained during the attacks. In severe cases extreme dyspnoea may occur.

Besides the attacks of spasms there are other manifestations of the disease. Disturbances of sensation are regularly present, especially pain, which is a frequent concomitant of the spasms. Hyperaesthesia, paraesthesia or anaesthesia may also be noted. *Temporary redness and oedema are not infrequently observed over the joints.*

Further, the evidences of *chronic idiosyncrasy* may develop. These consist chiefly in certain trophic disturbances such as loss of hair, dry skin changes in the nails, teeth, and lens, also metabolic changes resulting in cachexia. The manifestations of chronic tetany may persist for years.

A certain number of cases too numerous to be interpreted as accidental coincidences, present a combination of tetany with typical epileptic seizures.

Certain authors also include with the symptoms of tetany the hysterical attacks which are occasionally present.

Trousseau assumes three different degrees of tetany based upon the distribution of the spasms: first, a mild form, affecting the peripheral muscles only, some of these attacks being even limited to the hands; second, a moderate form with involvement of the facial, abdominal, and trunk muscles; third, a severe form extending to the involuntary muscles.

**Tests.** Of particular significance as bearing on the diagnosis are the tests of Erb, Chvostek, Trousseau and the leg test. These may be elicited during the free intervals or latent periods, and likewise after the subsidence of the attacks of muscular spasms.

*Erb's test* There is a marked increase of galvanic irritability of the motor nerves, especially the ulnar. Hyperexcitability is evidenced by contracture to abnormally mild stimuli KC AC AO and KO all being low. A kathodal opening contraction below 5 milliamperes is particularly significant. Erb's test is undoubtedly the most sensitive, reliable and accurate for tetany. It should always be used in a suspected case.

Trousseau's phenomenon can be demonstrated in two-thirds of all cases of tetany. The symptom consists in the occurrence of a tetanic spasm in a limb as the result of compression of its main nerve trunks.

Chvostek called attention to the facial phenomenon which can be elicited in tetanic patients by gently tapping over the area of distribution of the facial nerve. The resulting short twitchings are known as Chvostek's symptom.

In the leg phenomenon (Beinphaenomenon Schlesinger's sign, Pool's phenomenon) contractures are caused by putting the sciatic nerve on the stretch. For this test the patient is placed in a sitting position, with legs fully extended upon the thighs, and the trunk is then forcibly flexed upon the thighs by pressure exerted between the shoulders (Fig. 4). The contractures are preceded and accompanied by pain which may be severe enough to cause the patient to cry out. The feet become forcibly flexed (plantar) and adducted, assuming a position of marked equinovarus. This position cannot be altered by passive efforts however forcible. The muscles of the calf stand out conspicuously and become board-like to the touch. The onset of the pain and contractures begins from about 40 seconds to two minutes after the position is assumed. The pain may become so severe in a short time as to make it imperative to desist. The arm, tongue and Hoffman's tests are of little clinical value.

The course of tetany following thyroidectomy has been divided by Frankl Hochwart into three classes: (1) cases characterized by onset soon after the operation, severe course and fatal outcome; (2) cases in which the symptoms appear soon after the operation but subside after a variable time and are followed by recovery; (3) cases in which the patients live but present the manifestations of chronic tetany. It is necessary to extend this classification thus: there may occur latent tetany with no muscular spasms but with positive Chvostek's phenomenon and other kindred signs (von Eiselsberg). Moreover after the spasmodic attacks have ceased recurrences may take place especially under the influence of certain conditions which are practically the same as those with

which the onset of idiopathic tetany is associated namely pregnancy lactation cold seasons diet of meat, etc. (Guleke).

According to Guleke the prognosis of postoperative tetany is not good. From the cases which he compiled from the literature 5 per cent died and 17 per cent developed a chronic or markedly recurrent tetany. Iversen in his compilation found the death rate in postoperative tetany to be about 17 per cent.

*Treatment of tetany parathyreopræa* As soon as symptoms of tetany are noticed calcium lactate should be administered followed by parathyroid nucleoprotein. The calcium should be repeated as indicated the nucleoprotein should be given continuously. Although benefit has been claimed for calcium lactate given by mouth in doses of about 30 grains every four hours intravenous administration appears to be much more efficient (20 cubic centimeters of a 5 per cent solution with 100 cubic centimeters of normal sodium chloride solution). The nucleoprotein is administered subcutaneously or intramuscularly indefinitely 1 cubic centimeter of a 1 per cent solution being given three times a day.

Parathyroid transplantation is indicated when medical treatment seems of no avail or when the symptoms persist for a sufficient period to make it probable that spontaneous cure will not occur.

In view of the uncertain status of all proposed methods of treatment, the importance of prophylaxis is self-evident.

*Prophylaxis* In operations upon the thyroid gland it has been shown that not merely must sufficient thyroid be left in order to prevent the occurrence of myxedema, but that a sufficiency of parathyroids must be left so as to prevent the occurrence of tetany. The posterior part of one lobe must always be left, thus practically insuring a sufficiency of parathyroids with their blood supply. It is even safer however to leave the posterior parts of both lateral lobes.

#### ENDOCRINIC RELATIONS BETWEEN PARATHYROID AND THE SEXUAL FUNCTION

1. *General* Experimental studies have not established a definite interaction or mu-



tual relation between the parathyroids and the gonads. Partial parathyroidectomy has no influence on the histological structure and functional activity of the ovaries and testicles according to Alquier and Theuvsen. The effects of parathyroidectomy are not notably modified by the sex of the animal. In this connection it is of historical interest to note Silvestri's assumption of a close relationship between the parathyroid and the ovaries on the basis of the apparent freedom from tetany of adult female animals which had been castrated prior to the extirpation of the parathyroids whereas immature females as well as adult male animals died of tetany irrespective of the performance of castration. The fallacy of this observation was shown by Massaglia, Purpura, Cleret and Cley and recently by Meyer (1914). In all their animals death from tetany followed complete extirpation of the parathyroids even when the ovaries were removed before or after the parathyroidectomy.

The different phases of the female sex cycle especially the latter part of pregnancy and the period of lactation are known to exert marked influence on the production of tetanic spasms. By animal experiments Erdheim, Adler and Thaler showed that partially parathyroidectomized animals not only developed tetany after the operation but after recovery were again attacked in a subsequent pregnancy. Other animals which had remained free from symptoms of postoperative tetany presented such symptoms in later gestations. That is the pregnant state elicited tetanic spasms in the presence of diminished parathyroid function. In other words diminished parathyroid function creates a tendency to tetany which may not manifest itself until pregnancy supervenes.

Pregnant animals have been shown to react much more markedly to experimental lesions of the parathyroids than nonpregnant animals (Erdheim). The total removal of the parathyroids causes pregnant animals to abort and to die after a shorter period and under more violent tetanic symptoms than nonpregnant animals. The effects of partial extirpation serve to show that during pregnancy more parathyroid tissue is needed for

the preservation of life as well as for the avoidance of tetany than under ordinary conditions. The obvious conclusion is that the parathyroid function is relatively strained in the course of pregnancy.

The disturbances of the internal secretions, as related to pregnancy, childbirth, and the puerperium were discussed at the Fifteenth German Gynecological Congress, by Seitz, who emphasized with special reference to the parathyroids that although no distinct morphological changes have as yet been demonstrated in these organs the tetany of pregnancy is probably referable to parathyroid insufficiency.

2 *Offspring of parathyroidectomized animals.* The effect of total parathyroidectomy upon the power of procreation has been studied by Gulcke in rats in which postoperative tetany takes a chronic course. These animals did not procreate after total parathyroidectomy. Animals whose parathyroids have been only partially removed however may conceive and carry their young to term although abortions and still births are common. In a large number of the cases the young die in the first few days after birth. According to Vassale the milk of tetanic animals is often abundant and instead of harming the young causes them to develop better than others from the same litter which are raised on cow's milk.

3 *Parathyroid function as affected by the sex cycle in the female.* During menstruation the entire endocrine system is probably in a state of heightened activity. A failure of adjustment on the part of the parathyroids to this increased metabolism may lead to evidence of insufficiency with occasional culmination in the clinical picture of tetany. This is shown by case reports of Hoesslin and Lundborg. Following goiter operations, their patients suffered from tetanic spasms at each menstrual period. In contrast to these cases in which the menstrual processes elicited tetanic attacks in predisposed women, are observations on young girls suffering from idiopathic tetany who promptly recovered with the first establishment of the menstrual flow and on older women whose tetanic symptoms disappeared at the beginning of a men-



Fig 1 Principal cells. (Photomicrograph reproduced from Tetany Parathyreopriva Pool, *Annals of Surgery* 1907)

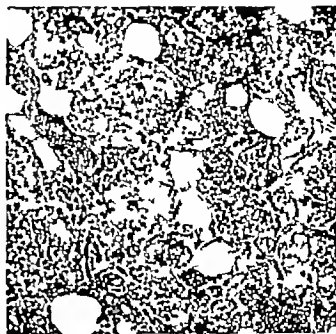


Fig 2 Masses of oxyphil functional cells. (Photomicrograph reproduced from Tetany Parathyreopriva, Pool, *Annals of Surgery* 1907)

strual period. Moreover occasionally tetany has been known to occur primarily as a sequel to menstruation sometimes manifesting itself after each menstrual period. It is difficult to draw conclusions from the evidence at hand further than to state that a tetanoid state and chronic tetany tend to aggravation about the menstrual periods.

Parathyroid lesions have recently been held responsible for puerperal eclampsia by Vassale but this view is opposed by others notably by Seitz on the ground of negative tests of galvanic nervous irritability in a number of eclamptic patients. Moreover no morphological proof has been adduced to the parathyroid theory of puerperal eclampsia. According to the investigations of Allegri and others the parathyroid glands appear practically normal in these cases.

4 *Maternal tetany* (tetany during pregnancy and the puerperium). Tetanic spasms occurring in connection with the childbearing processes represent one of the oldest known forms of the disease. Trousseau described the condition in 1854 as *contractures des nourrices* but it had already been recognized by Dance and Steinheil (1830-31). An important contribution to the subject by Frankl Hochwart contains 53 cases from the literature

and 23 personal observations. Opinions differ as to the relative frequency of gestation, puerperal, and lactation tetany respectively. The puerperium and the suckling of the child are held by some to be far more responsible than the pregnant state but it is maintained by others notably Seitz, that from 80 to 90 per cent of the cases begin before childbirth while only a small number occur exclusively during lactation. The time of predilection for the onset of tetany appears to be in the second half of pregnancy beginning with the sixth month, but the contractions may appear in the early months or during parturition.

A disturbance of parathyroid function must be held responsible for maternal tetany. The clinical picture of the disease corresponds accurately to that of tetania parathyreopriva. The dependence of maternal tetany on insufficiency of the parathyroids has been shown by means of animal experimentation as well as by observations upon strumectomized women who after the removal of a goiter were attacked by tetany in later pregnancies.

A twofold explanation was advanced by Chvostek, in 1905 for the existence of a special predisposition

tetany during gestation and in the puerperium. The parathyroid function, he argues, may be taxed to an increased degree by the childbearing process or it may be impaired by unknown influences. It is known possibly to be relatively improved in men in calcium metabolism the result being an equilibrium of the parathyroid. When the parathyroid function is inadequate in the presence of pregnancy, tetany supervenes although under ordinary conditions the functional capacity of these organs may be compatible with health. This is supported by the observation that tetany symptoms disappear after delivery and the condition is taken.

In the consideration of maternal tetany recent writers lay emphasis upon the supposition that the function of the parathyroid is dependent upon a sufficiency of calcium. Although it has been shown by MacCallum that the calcium content of the blood is lessened in tetany and that calcium is of therapeutic value in other words that in sufficiency of the parathyroid is associated with deficiency of calcium it has not been proved that diminished calcium in the organism produces incapacity of the parathyroid. Nevertheless theories based upon this assumption are plausible and will be outlined.

As pointed out by Kehrer the tissues, more particularly the central nervous system may be deprived of their calcium contents through increased calcium excretion in body fluids such as blood, milk or urine or through neutralization of the calcium by acids. A reduction in the calcium content of the body is physiological within certain limits in pregnant and puerperal women but it is assumed once this limit has been exceeded tetany is likely to appear when the parathyroid is imperfectly developed or functionally deficient. In pregnancy the calcium of the maternal organism is drawn upon for the structure of the foetal tissues. During parturition calcium is lost with the blood. The nursing mother loses calcium with the milk. If it is accepted that the parathyroid is incapacitated by lack of calcium the significance of all these physiological conditions is fateful. The calcium impoverishment of the organism imposes a tax upon the parathyroid function with the result that tetany may supervene in women having hypoplastic or otherwise deficient parathyroid glands.

The existence of a subtetanic condition is now assumed by Seitz and Thierry on the basis of important investigations in 10 per cent of all women during the last months of pregnancy or in course of childbirth.

The galvanic irritability of the nerves was found to be increased in the last months of gestation in 60 per cent of the seventy healthy pregnant women examined and a still further increase of nervous irritability was found at the time of birth. In 10 per cent of the women examined such a degree of electric irritability as found during childbirth was observed only in tetany during the puerperium the irritability returned to normal. It is noteworthy that with a single exception none of the examined women had suffered from tetany.

Latent tetany has been claimed by Kehrer to be more common in pregnant and puerperal women than is usually assumed. In his experience positive findings were noted in 5 per cent of the cases, in the latter half of pregnancy as well as during the first ten days of the puerperium. Kries found a positive Chvostek phenomenon with galvanic hyperirritability of the facial nerve in 10 per cent of pregnant women and in 8 per cent of all puerperal men. The recognition of incipient tetany has been based upon the symptoms as tingling sensation in the hands and feet, Chvostek's facial phenomena and slight hyperirritability.

Kehrer states it has been noted not infrequently in our own pregnancies and there is a tendency for the symptoms to become more severe with each pregnancy and to occur earlier months. Some women are entirely well during the intervals, while others suffer from a more or less severe chronic type of the disease.

The onset of maternal tetany is extremely variable. In the great majority of the cases, the tetany of childbearing women is of a mild type and the patients recover. Trophic disturbances of the skin and its appendages are common and are usually referred to toxins circulating in the blood. The most serious sequel is represented by cataract formation the general nutritional disturbances, apparently possessing special etiological significance in this respect. Women suffering from maternal tetany are apt to be weak anemic individuals many of them weakened by a considerable number of pregnancies and births in rapid succession.

In the severest cases, representing the fulminating type of maternal tetany which may terminate in death at the height of the attack, the onset is sometimes abrupt with marked dyspnoea, cyanosis, and loss of consciousness. Life is endangered through the possible extension of the tetanic spasms to the diaphragm and respiratory muscles. Laryngospasm is an occasional cause of death. The mortality of tetany in pregnant women,



Fig. 3 Parathyroid gland to contrast relationships of thyroid, x parathyroid v recurrent laryngeal nerve inferior thyroid artery, a and esophagus p (Pool and Falk, *Annals of Surgery* 1916)

according to Seitz amounts to 7 per cent. In the experience of Marek of ten mothers with tetany nine of them multiparae three died.

The tetany of pregnancy in some cases persists during the puerperium in others the attacks subside in the first few days after birth. In her next pregnancy the patient may be again attacked or this pregnancy may be normal and she may remain free from spasms until a later one. Some women are entirely well during the intervals while others suffer from more or less severe chronic tetany. The occurrence of premature labor may rapidly terminate the disease in pregnant women.

A case of tetany which has come under my observation is of interest in connection with the consideration of maternal tetany.<sup>1</sup>

The woman 27 years of age has undergone 3 operations for goiter by different surgeons 5, 10 and 12 years ago. I am informed that at the third operation February 1, 1912 the right lobe was removed *in toto* only the isthmus being left. The left lobe of the gland had evidently been excised at a former operation, as inspection of that side is

said to have revealed no evidence of thyroid tissue. The healing of the wound was uncomplicated.

On the third day after operation tonic contractures occurred with cramp-like pains in the fingers and hands, which assumed the position known as *acrobach's hand*. The patient also had cramp-like pains in the calves.

On the fourth day calcium lactate was given hypodermatically. Tonic contractures of the fingers of the left hand with cramp-like pains lasted from 9 p.m. to 1 a.m.

I saw the case for the first time on the next day and made various tests finding an astonishingly marked hypersensitiveness of the motor nerves as indicated by Erb's, Trousseau's, Chvostek's tests and the leg and arm phenomena.

On the sixth day implantation of a parathyroid removed from a young male in an operation for simple goiter. The implant was placed in the preporitoneal tissue behind the right rectus sheath.

Seventh day forcible contractures with severe pains in the parts affected. The elbows were flexed at a right angle wrists and fingers were also forcibly flexed. The attack continued from 5 a.m. to 11 a.m.

No further attacks of tetany were noticed up to the time of the patient's discharge. Shortly after her discharge she had one brief attack lasting about a minute characterized by pain and contractures in right calf.

The woman subsequently married and passed successfully through two pregnancies.

April 7, 1913 baby born. August 1913 baby



Fig. 4. Maternal tetany. The patient is shown in a contracted position of the arms and hands.

diagnosed as tetany. The patient was in a contracted position of the arms and hands. In August 1914, the patient was in a contracted position of the arms and hands. She also had tetany since the birth of the child after a charge from hospital.

The patient was in a contracted position of the arms and hands. She also had tetany since the birth of the child after a charge from hospital.

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**5 Lactation tetany.** The designation rheumatic contracture of nursing women was proposed in 1854 by Trousseau for a condition observed by him in a number of cases. Loss of parathyroid competence is in general held responsible for lactation tetany as well as for other forms of tetany connected with the female organs of generation. The onset of tetany after childbirth is less common in mothers who do not nurse their children than in nursing mothers. The tetany is said to be caused by the prolonged secretion of calcium containing milk. In women suffering from a mild form of chronic tetany the disease sometimes becomes aggravated during lactation. Tetany has been known to occur within the first week after childbirth, and also after a latent period of two to eight months. This form of tetany has less tendency



Fig. 5. Postoperative tetany. The patient is shown in a contracted position of the arms and hands. The result of extreme abduction of the arm is shown.

to recurrence than gestation tetany the proportion according to Kehrer being as 2:8. Whereas lactation according to Meiner plays a more important rôle in the etiology of maternal tetany than does gestation it is claimed by Seitz that from 80 to 90 per cent of the cases begin during pregnancy and that only a relatively small number have their origin during lactation.

**6 Resemblance of clinical picture of maternal tetany to that of tetany parathyropræa.** The remarkable conformity of the clinical pictures of maternal and postoperative tetany first led to an investigation of parathyroid insufficiency as the possible underlying cause. The dependence of maternal tetany on a disturbed function of the parathyroids has been illustrated both by animal experiments and by observations upon women who after the extirpation of a goiter were attacked by tetany in later pregnancies. In support of this view an interesting observation was made by Kehrer on a para who died on the twelfth day of the puerperium a few days after being attacked by tetany. Instead of the four normal parathyroids the autopsy showed only a single parathyroid gland, and even this was reported as apparently abnormal.

**7 Tetany in gynecological diseases and after gynecological operations.** In cases of uterine fibromyomata and purulent endometritis tetanic spasms and tetanoid conditions have been reported.

Thus a woman of 28 years observed by Kehrer while suffering from a profuse purulent discharge, complained of dragging and tingling sensations with painful tension in both hands and feet. The reflexes, especially the knee jerks, were very lively and Chvostek's phenomenon was well-marked on both sides. After two days diminution of



Fig 6 Leg phenomenon showing plantar flexion of foot as a result of forcible flexion of trunk upon thighs with knee extended

calcium the symptoms suddenly subsided and did not reappear

As a sequel to *uterine curettage* and *major gynecological interventions* tetany develops in rare instances. It is sometimes definitely preceded by a tetanoid condition. As a rule the spasms make their appearance immediately or soon after the operation. For good descriptions of these postoperative tetanies we are indebted to Kehrer in Germany and Stein in this country. The gynecological interventions after which tetany has been observed include curettage for uterine hemorrhage and incomplete abortion, ventral fixation of the uterus, plastic operations on the perineum, colporrhaphy, extirpation of vaginal cysts and of ovarian tumours. A few illustrative cases will be summarized.

Gross describes the case of a woman 30 years of age whose uterus was curetted after abortion in the second month. At the beginning of the operation the patient underwent a typical attack of tetany. About nine months later the uterus was again curetted on account of persistent menorrhagia; a similar attack of tetany followed. Reference is made to the presence of a hard nodule the size of a walnut in the region of the thyroid gland.

Typical tetanic spasms were observed by Goth immediately after the performance of a plastic operation on the perineum in a 25 years of age; the spasms were repeated about every three hours, lasted from two to five minutes and caused rather severe pains. Both hands were held in the accoucheur position and the feet and toes in plantar flexion. The last attack of tetany occurred on the thirteenth day following the operation.

In a case reported by Kehrer a woman 41 years of age, typical tetany occurred in connection with reposition of a retroflexed myomatous uterus under light ether anesthesia.



Fig 7 A type of contracture of hand and wrist in tetany

8 *Tetany in the newborn.* A relation between infantile tetany and disturbed parathyroid function is suggested by the conformity of the clinical manifestations with those of tetania parathyreopriva. Typical tetany of the newborn manifests itself soon after birth in the offspring of tetanic or tetanoid mothers and the children rarely survive longer than a few weeks or months. The infants of tetanic mothers sometimes suffer from typical tetany but often have merely the so-called tetanoid symptoms especially a well marked Chvostek phenomenon. The infant's condition is probably due to prenatal causes. An increased tendency to tetany was noted experimentally by Iselin in the young of parathyroidectomized animals. In all the cases of tetany in the newborn observed by Kehrer the children were born after an easy labor without instrumental assistance and the convulsions could not be referred to obstetrical traumatism. Serial sections of the parathyroids of eight older children who had died from tetany were made by Haberland in whose opinion the disturbances of growth and hypoplasia of the organs with subsequent functional insufficiency may be the result of hemorrhage into the substance of the glands.

Tetany of the newborn usually attacks weakly and premature infants. In the five cases reported by Kehrer the disease made its appearance within the first week after birth. With one exception the



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## THE THYROID GLAND IN RELATION TO GYNECOLOGY AND OBSTETRICS

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THE relation of the thyroid to the sex organ in the female is the most ancient and classical illustration of the interrelation of the function of the gland with internal secretion. Known to the ancients in its crudest external manifestation as a subject of thyroiditis goes up it has passed down through the ages. Even today in spite of the records of the usual observations and experiments we must confess to a very meager insight into the fundamental physiological processes involved.

Experimental approach is difficult. The lower animal lacks the obvious manifestation seen in man. The search for hormones, chemical catalysts and depressors is still in its infancy. However many facts of importance are known and I shall review some of them in the following pages.

Of the several possible uses whose activities may be concerned the thyroid adrenal and sex gland appear most important. The adrenal medulla is important because of the effect of its hormone on all sympathetic nerve ending the adrenal cortex because embryologically it is identical with the interstitial cell of the ovary. Both the adrenal cortex and interstitial cell are characterized by a high lipid content the physiological rôle of which is unknown although there are many facts to indicate that it is of great importance. Both tissues reciprocate in their physiological hyperplasia and decreasing from analogy with the male these lipid rich interstitial cell probably play an important rôle in the development and maintenance of the secondary sexual characteristics.

Ancestrally the thyroid exists in the chordates in two forms: as an elaborate ventral midline pharyngeal glandular groove the so-called endostyle in all the lower chordates—tunicates amphioxus and ammocoetes (larval lampreys) and as the familiar ductless thyroid in all higher chordates—adult lampreys, fish amphibians reptiles bird and mammals. Fortunately the animal (lamp-

rey) in which the transition from endostyle to thyroid can be followed still exists, otherwise the extraordinary metamorphosis could not have been established.

The thyroid then is primarily a pharyngeal gland probably closely related both to digestion and respiration and in the thyroid of higher animal all its known activities are intimately related to metabolism. Variation in size within physiological limits are characteristic of all three of these tissues. In man the dog and the cat it is the thyroid which shows the largest variation while in rabbits the adrenal cortex and ovaries show greater variation in size than the thyroid.

It is usually stated that the thyroids in women are larger per unit of body weight than in men. This is in general true so far as anatomical statistics can go but it has misled some authors to imply that the difference is inherent while in truth it is acquired and can be entirely controlled.

All the known physiological activity of the thyroid is associated with iodine. Used in ignorance from the most remote times in the form of sponge ash seaweed crude salt etc. in the treatment of thyroid enlargement, discovered as an element in 1811 by the Frenchman Courton first knowingly used in medicine by the Geneva physician Collet in 1820 it remained for Baumann of Freiburg to discover it as a normal constituent of the thyroid in 1891. Iodine is usually present only in traces in the thyroid at birth unless the mother has been given iodine when it is enormously increased. In the normal gland there are wide variations in the iodine content. The average is about 0.1 per cent of the dried weight or from 10 to 1 milligram in the whole gland. The iodine-containing hormone is bound with the globulin of the colloid from which Kendall has recently been able to separate it by alkaline hydrolysis and to obtain it in crystalline form. Its chemical nature is unknown though Kendall thinks it is a diiodoindol.

In general the iodine of the thyroid varies with the amount of colloid. Iodine is markedly decreased in the developmental stages of all goiters and following the administration of its soluble salts it is almost instantly taken up by the thyroid. Physiologically this iodine-containing hormone is the most powerful activator of metabolism known. This effect appears to be brought about through stimulation of the oxidation processes and if the work of Asher and Flack and of Cannon and his co-workers is confirmed the influence of epinephrin is very important in augmenting its action and vice versa the influence of the thyroid hormone greatly augments the pressor activity of epinephrin. With our present knowledge we attempt to explain the instances of increased functional activity of the gland on the basis of an increased demand for thyroid activity or what amounts to the same thing an increased demand for the iodine-containing hormone.

Thyroid enlargements appear to be compensatory or work hypertrophies and are readily controlled or prevented by the administration of very minute amounts of iodine. Removal of the thyroid is followed by similar basic symptoms in both young and adult animals. They all depend upon depression of the various activities of tissues and a decrease in total metabolism. In the young this change manifests itself in arrested growth and development sexual, somatic and mental—the so-called cretin. In the adult, loss of sexual functions increased fatty deposits mental deterioration anemia and malnutrition of all the tissues are the most prominent manifestations. There is no evidence of selective action or that certain organs or groups of organs are more affected than others. Superficially this might seem to be the case because certain symptoms, like those of the nervous system or genital system are more obvious and earlier recognized.

Removal of the thyroid like removal of the ovaries or adrenals is usually accompanied by persistence of the thymus spleen enlargement enlargement of the lymph glands and a lymphocytosis. Nothing is known as to the phase of these changes. Removal of a large portion of the adrenals in rabbits causes

slight, though definite hypertrophy of the thyroid and lymphoid hyperplasia. This is also seen in Addison's disease in man and might be explained as part of the adrenal thyroid interrelation.

Removal of the adrenals also causes hypertrophy of the interstitial tissue of the ovaries in rabbits and removal of the ovaries causes hypertrophy of the adrenal cortex or even of subcutaneous transplants of adrenal cortex.

Removal of the ovaries in animals probably tends to decrease the activity of the thyroid. There is no evidence that this is a direct effect. The various attempts to establish a direct relationship between the thyroid and ovaries by a comparison of the influence of extracts on metabolism have given negative or doubtful results. Through the study of cryptorchids and experiments of ligating the vas deferens it has been definitely established that the interstitial lipid rich cells of the testes largely determine the male secondary sexual characters. In the case of the ovary it is not possible to separate the oogenic cells from the interstitial cells but the attempts thus far made suggest that these cells play a very important and similar rôle in the secondary sex characters of the female.

Nevertheless it is an outstanding fact that in man thyroid hyperplasia is many times (6 to 8) more common in the female during and after adolescence than in the male during and after adolescence. Up to this period sex makes no difference in the incidence. Congenital goiter is not influenced by sex and in all the lower animals sex likewise has no influence the incidence remaining the same at all periods of life.

In the human subject, the periods when thyroid enlargements most frequently occur are at puberty, during menstruation and during pregnancy. During each of these periods the body metabolism is increased and as it is a major function of the thyroid to stimulate oxidation processes in the body, it is probable that the heightened metabolism is of thyroid origin and the enlargement of the thyroid at these times is a true work hypertrophy. This view is supported by the facts that supplying the iodine-containing

hormone artificially or even iodine from which the gland can elaborate its own hormone in increased amounts prevents the hypertrophy and in any developing hypertrophy of the gland the iodine is decreased. In rut and pregnancy of the lower animals these changes are too slight for certain detection though many authors have reported mild degrees of thyroid hypertrophy in both rut and pregnancy. I have given considerable attention to the study of this feature and have never been able to detect any change in size, histological appearance or iodine content greater than the range of changes found normally in either sex unassociated with sexual activity. An increase in metabolism occurs in animals also during rut and pregnancy and therefore some increase in thyroid activity is probable but it is too slight to be recognized by morphological or chemical changes in the thyroid as can often be done in man.

The degree of change in the thyroid during puberty, menstruation and pregnancy is normally slight amounting to no more than the enlargement incident to the increased blood supply. Occasionally hypertrophy of the epithelium occurs and always there is some decrease in the iodine content. Cellular hypertrophy is not possible until a great drop in the iodine has taken place. In the dog, ox, sheep, pig and man it has to fall to less than 0.1 per cent as compared with a normal of over 0.2 per cent of the dried weight. These anatomical changes are identical with those which occur in developing goiters, and in goiter districts it is at these periods that simple goiter most frequently develops. The development of great enlargements of the thyroid at these periods merely means the coincidence of the cyclic sexual factor with the continuously operating causal agent of simple goiter and must not be confused with the slight increase in activity or better the slight temporary insufficiency of the thyroid of sexual origin.

It is possible that the same chemical disturbance initiates the thyroid change both in sexual activity and in simple goiter the difference being one of degree. This is purely a speculation, for experimental work so far

has furnished no suggestive lead as to the exciting cause of either. Nor has the study of menstrual disturbances of the pathological physiology of pregnancy or of diseases of the genital tract thrown any light on the nature of the thyroid reaction associated with sexual activity.

The extensive study of the relation of the sex glands to Basedow's disease likewise has given no clue to the nature of the thyroid sex gland interrelation though the incidence as regards sex is similar to that of simple goiter.

*To summarize.* It may be stated that there is evidence in man of a thyroid sex gland interrelation recognizable in the female in association with the development of secondary sexual characters with menstruation and with pregnancy and also in the male at puberty but to a very slight degree. The meager evidence available would tend to indicate that the interstitial cells of the ovary and perhaps also the adrenal cortex play a major rôle in this relation in the female as certainly the cells of Leydig do in the male.

The thyroid enlargement is of the nature of a work hypertrophy to stimulate metabolism identical in appearance and so far as we know different only in degree from that seen in simple goiter. Both of these reactions can be controlled and prevented either indirectly by giving iodine or directly by giving the iodine-containing hormone in physiological doses.

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## THE THYMUS GLAND AND ITS POSSIBLE RELATION TO THE FEMALE GENITAL TRACT

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## INTRODUCTION

THE vigorous research that has been expended upon the thymus gland during the past few years has not on the whole been very fruitful. That the thymus serves an important function especially in the growing organism cannot be doubted. The organ is conspicuously large has a characteristic structure which is maintained with but slight variations in all classes of vertebrates, reacts in a very definite way to a variety of injuries and has a constant relation to the development of the sexual organs. There are furthermore obscure but undeniable correlations with thyroid adrenal and possibly other organs of internal secretion. Although these general facts seem established yet in every detail of structure and physiology there has been and is, the greatest conflict as to facts and interpretations.

It is indeed no easy task to find one's way about through the maze of conflicting statements and it is particularly difficult, in the present state of our knowledge to draw any far reaching conclusions as to the importance of the thymus in relation to the disorders of the female genital tract. In preference I shall try to present a brief general oversight of our present knowledge of the thymus, based upon a critical study of the work of others and upon my own studies in this field and shall then review somewhat more in detail the work which bears upon the relation of the thymus to the genital organs.

## I. ANATOMY AND HISTOLOGY

There is at present very satisfactory agreement in regard to the finer structural features of the thymus. Through the studies of Hammar (1) and of Maximoff (2) and his pupils we have come to regard the thymus as an epithelial organ invaded by lymphocytes from the adjacent mesenchyme these proliferate within the gland and come later to form the

bulk of the thymus tissue. The epithelial component, however persists as the reticulum and enters throughout the formative period into the peculiar cell complexes known as the Hassall bodies.

The thin walled blood vessels which penetrate the lobules from the interlobular septa are accompanied by sheaths of connective tissue but there is no general fibrous reticulum such as is present in lymph glands. The framework in the meshes of which lie the thickly crowded lymphocytes, is formed by the branching and anastomosing epithelial cells.

The genesis and nature of the small thymus cells has been much discussed. It has been maintained by Stoehr on histogenetic grounds that, in spite of their resemblance to lymphocytes they are in reality epithelial in origin and nature. This view is still accepted by Metens (3) Schröder (4) Földi (5) and others but the balance of opinion is greatly in favor of their being true lymphocytes. Morphologically the small thymus cells are identical with lymphocytes to the last detail. They show typical amoeboid mobility under suitable conditions. Their complete independence of the epithelial constituents of the gland has been demonstrated in tissue cultures by the writer (6) and by Wassén (7). Under these conditions the small thymus cells wander out early into the plasma, and degenerate within a relatively short time being phagocytized by the epithelial elements, and showing no proliferative capacity. The epithelial cells, on the other hand, after a latent period of 24 to 36 hours, show active growth into the plasma often in the form of coherent sheets of cells, a manner of growth that we are accustomed to regard as characteristic of epithelium.

I have lately been able to bring further evidence in favor of the biological identity of the thymus lymphocytes with those from lymph glands (8). A cytotoxic serum pre-

pared by immunizing a rabbit with thymus lymphocytes both agglutinates and cytolizes suspensions of lymphocytes. On the whole, therefore we may regard it as assured that the thymus is a lympho-epithelial organ in which the two types of structures coexist in the most intimate relation. Indeed one cannot doubt that there must be some purpose in this symbiotic relation. Even in the normal gland the fragile lymphocytes are constantly destroyed and replaced and the whole cells or fragments of their nuclei taken up and digested by the epithelial cells and this process goes on apace under a variety of pathological conditions.

## II THE THYMUS AS A SECRETORY GLAND

What histological evidence have we that the thymus is a secretory gland in the ordinary sense? Mitochondrial granules and filaments can be demonstrated in the lymphoid cells and occasionally larger droplets some of them lipid in nature are found in the epithelial cells and larger cell complexes which enter into the formation of the Hassall bodies. There is no evidence that these are secretory products. The histological structure however does not in the least suggest a typical glandular arrangement, as exemplified in the thyroid parathyroid the anterior hypophyseal lobe the adrenal cortex or the islands of Langerhans. The vascular supply is less abundant than in these tissues, and the capillaries do not enter into intimate relation with the individual cells.

All this speaks against the idea that the thymus elements discharge preformed secretion products directly into the blood stream

## III DISINTEGRATION OF NUCLEAR MATERIAL

The more one studies the thymus the more certain becomes the conviction that the constant, and under some conditions, excessive disintegration of nuclear material is the most obvious form of activity which takes place in this organ. It would serve no purpose at the present time to speculate further on the meaning of this process but here I think we shall in time find a clue to the chemical function of the gland

## IV NORMAL DEVELOPMENT AND INVOLUTION

There is one other anatomical feature of the thymus which deserves emphasis. This is its progressive growth up to the onset of sexual maturity followed by its subsequent involution. The recognition of this fact we owe to the painstaking studies of Hammar (1 and 9) and his pupils. It holds true not only for the human thymus but for all classes of vertebrates even the cartilaginous fishes. This well established but by no means generally acknowledged fact disposes at once of an enormous casuistic literature, in which the presence of healthy gland tissue in normal amount is interpreted as abnormal persistence or hyperplasia.

## V EXTIRPATION EXPERIMENTS

Probably the most interesting part of the voluminous thymus literature is that which deals with the effect of experimental extirpation. According as one accepts the results of one or other group of investigators the thymus is revealed as an organ indispensable to orderly growth to the proper ossification of the skeletal system to normal intellectual function indeed to continued life itself or on the other hand if one remains unconvinced the thymus falls in dignity to an organ the loss of which is readily compensated for an organ which has no specific relation to bone formation or to calcium metabolism in general in short, the status of the thymus as a specialized gland of internal secretion becomes a matter of grave doubt.

I cannot review in detail the numerous experiments of this class which began with Restelli (10) in 1845 and have been prosecuted up to the present day. All the common domestic and laboratory animals have at one time or another been used as operative material and with the most discordant results. The older work in which asepsis was disregarded, the completeness of the operation often uncontrolled and the possible existence of accessory thymic tissue ignored is chiefly of historical interest.

Of those workers who have obtained definite effects from thymectomy within recent years we need mention only Basch Klose and

Matti all of whom have used dogs as their principal operative animal

Basch (11 and 12) found in his thymectomized puppies after a latent period of two to three weeks, an increase in softness of the bone accompanied by arrest in growth and apparent defect in intelligence. Later (13) he reported the occurrence of galvanic hyperexcitability in his thymectomized dogs less intense however than in experimental parathyroid tetany.

The studies of Klose and Vogt (14, 15, 16 and 17) have attracted much attention, and seemed for a time to have put the entire thymus question upon a firm experimental basis. With a good *gusto* details, Klose's work may be summarized briefly as follows. Thymectomy in dogs performed before the twentieth day is followed by a latent period of two to four weeks during which the puppies show normal growth and behavior. This is followed by a state of adiposity lasting two to three months during which time the weight curve runs parallel to the control but the general habitus and behavior differs from those of healthy animals. The puppies fatigue easily, the gait is awkward and waddling, the bones feel softer and more elastic. The intelligence is impaired and the behavior pathetic.

After three to four months there is said to ensue a terminal cachectic stage ending in death after a period varying from three to fifteen months. In addition to the cachexia Klose observed marked retardation of growth, great muscular weakness and in the terminal stage apathy deepening into coma. A tendency to intercurrent infections, especially corneal ulcerations was striking.

As regards the specific changes in the bones which Klose and Vogt often allude to, a rachitic critical analysis leaves one in doubt. There are many discrepancies in their descriptions which makes the analogy to true rachitic lesions doubtful. Matti (18) however who in 1913 repeated Klose and Vogt's extirpation experiments on dogs described and pictured in his animals lesions which are unquestionably rachitic. Whether these bone changes are to be regarded as due to lack of thymus secretion, as Matti holds is another question.

As regards the effect of thymectomy in animals other than dogs, the results as has been stated have been contradictory. In white rat Klose (9) Magnini (20) and Fleisch (21) have obtained positive results comparable with those of Klose in dogs.

There is then a massive array of experimental work in favor of the view that the thymus is an essential organ, exerting a controlling influence upon growth and bone formation. In spite of conflicting details the importance of the thymus appeared to rest on a firm basis. As Lampé (22) has said its honor seemed to have been retrieved. Unfortunately a number of

workers have quite failed to substantiate these positive findings.

Thus Nordman (23) operating on dogs between the tenth and fourteenth days using strict asepsis, tracheal insufflation, wide exposure of the mediastinum and strict histological control as to the completeness of the operation, produced neither nutritional or skeletal changes. There was no increased susceptibility to infection, no correlated effects upon sexual glands or spleen and, contrary to the statements of Klose and others, subsequent splenectomy in these animals was well borne.

Howland, McClure and Park at Johns Hopkins University have for several years been working on this problem. Their complete results have not yet been published but preliminary report in 1914 (24) and recent personal communications assure me that they also have obtained negative results. They as well as Nordman, have been alive to the importance of keeping their animals under hygienic conditions.

The latest publication on the subject is that of Park (25) on guinea pigs. His results in these animals were wholly negative but he shows that the almost constant presence of the accessory thymic tissue in the guinea pig makes this animal unsuitable for a determination of the question as to whether the presence of thymic tissue is essential to life.

My own work on rats (26 and 27) in which the thymectomy was performed on very young animals and the completeness of the extirpation as well as the absence of accessory thymic tissue controlled by serial sections has convinced me that Klose and his successors are in error so far as the effects of thymectomy in this animal are concerned. In a fairly large series in which the extirpation was complete and in which no accessory thymic tissue could be demonstrated no difference in growth or in bone development from control animals of same litter were found.

Furthermore I had the opportunity of studying rachitic lesions of great severity in rats (28) but these occurred not only in completely thymectomized animals, but in those with partial extirpations in unoperated controls of the same litter and in unrelated animals from the stock cages. This disease long ago accurately described by Morpurgo (29) is a spontaneous one altogether unrelated to the removal of the thymic tissue.<sup>1</sup>

<sup>1</sup> In recent article Reuben and Robertson (30) Path. and Bacteriol. 53 (3) conclude that spontaneous rachitis gives rise to exactly the same symptoms as Basch, Klose and Vogt, and Matti attribute to thymectomy. That the removal of the thymus does not make the animals more susceptible to spontaneous rachitis and that thymectomy at least does not appear to cause any symptoms.

My personal conviction therefore, is that the loss of the thymus in young animals is not of prime importance and is readily compensated for in ways that are not yet understood. I believe further that the disturbances in osteogenesis so frequently emphasized in the experimental literature are best explained by the fact that young animals kept under laboratory conditions are notoriously susceptible to rachitis as well as to intercurrent infections and nutritional disturbances of all sorts. Confirmatory evidence that the thymus is not concerned in the production of rachitic lesions is found on the autopsy table. Klose and others are very vehement in attributing the negative results of other workers to incomplete extirpations or to the presence of unrecognized accessory thymic tissue. But in human rickets thymic tissue is always present in abundance the amount of course varying with the general state of nutrition. Indeed there are no pathological states known in man in which one finds a complete absence or destruction of the thymic tissue so that, even if one accepts in their entirety the claims of certain experimental workers their results seem to have little bearing on human pathology.

#### VI HYPERTHYMIZATION

The attempts at experimental hypertrophy up to the present, have added little of fundamental importance. It has not been possible to isolate from the gland by chemical means substances having a definite physiological action. The depressor effect which follows intravenous injection of thymic extracts has been variously interpreted. It is probably not specific, and at any rate there is not the slightest evidence that the thymus *in vivo* furnishes vaso-depressive substances to the circulation. Indeed it is hardly to be expected that injection of variously prepared extracts of such a complex tissue as the thymus can yield information of great value.

The feeding experiments of Gudernatsch (30, 31 and 32) which have received confirmation from the work of Romeis (33), Kahn (34), Stettner (35) and others seem to indicate a stimulating influence upon the

growth of frog larvae, accompanied by an arrested differentiation. I was able to observe a somewhat similar effect upon the regeneration of the tail segments in lumbriculus. These effects, however seem to be less clear cut than in the case of thyroid extract which accelerates involution of the tadpole tail and is at the same time toxic. At best such highly artificial and complex experiments throw little light on the normal function of the gland.

#### VII PATHOLOGICAL CHANGES

The pathological changes which take place in the thymus are with the exception of the tumors very simple and may be summed up as atrophy and hyperplasia. Aside from the atrophy or involution which follows normally upon the attainment of sexual maturity there occurs in the gland an accidental involution, to use Hammar's term under the influence of the most diverse conditions: acute and chronic inanition, infection of all sorts and such special forms of injury as the X-ray. All these factors bring about, in ways that are still obscure a massive destruction of the thymus lymphocytes with secondary reaction on the part of the epithelial components and connective tissue.

We have been engaged during the past winter in studying the reactions of the thymus lymphocytes *in vitro* (36) to a variety of injurious agencies in the hope of finding some clue to the meaning of this extraordinary fragility and the precise factors which bring it about. Many types of injury such as changes in H ion concentration, asphyxia, starvation, old age, specific immune sera, various chemical agencies could be shown to act harmfully upon the cells outside the body but no hint was obtained as to the significance in the organism of this dissolution of nuclear material en masse. Here however let me repeat again, seems to be the most promising lead to an understanding of the chemical function of the organ.

#### VIII HYPERPLASIA

The significance of thymic hyperplasia is as obscure as its atrophy. One should distinguish in principle at least between the mere persistence of the gland or better its retarded involution and a true hyperplasia or increase in the number of its elements beyond the limit normal for the correspond



ing number for its age. Both conditions unquestionably occur. Retarded involution follows extirpation in early life, and is associated with the retention of other juvenile characteristics. It is one feature of that peculiar anatomical conformation in adults which we designate rather vaguely status lymphaticus. I do not think it is the cardinal feature nor that the thymus is in any way concerned except in so far as its persistence into the third or fourth decade may be taken as an index of the persistence of the juvenile habitus in this type of individual. Certainly no proof has yet been offered that the gland is in any way concerned in the mysterious sudden death which may overtake these peculiarly constituted persons.

A true hyperplasia in which the weight and the amount of the parenchyma exceeds the wide normal limits of variation for the particular age undoubtedly occurs also. In the newborn and in older children one occasionally meets with thymi of unusual size. I have for example seen a gland of 60 grams in a newborn, the average weight in full term healthy infants being from 10 to 12 grams. That such abnormally large glands may occasionally give rise to pressure phenomena seems probable and yet the actual proof is difficult to bring and a critical study of the casuistic literature upon thymus asthma and thymus deaths in young infants makes it clear that many of these cases are open to other interpretations. Von Suty (37) deserves the credit of pointing out that many of the cases of sudden death in young infants associated with suffocative attacks and clinical signs of asphyxia are due in reality to a capillary bronchitis.

My own autopsy experience at the Nursery and Child's Hospital fully confirms this point. In older children when the weights of the glands are compared with those of healthy children dying suddenly from accidental causes, which alone should be taken as a normal standard, it will be found that glands of excessive weight are not very frequently reported.

#### IX. INTERRELATION WITH THYROID

The occurrence of a true hyperplasia of the thymus in the great proportion of cases of exophthalmic goiter has come to be recog-

nized as a distinctive feature of the disease, and the recent tendency has been to make this organ share in the production of the symptoms. Among others Garré (38) von Haberer (39) and in this country Halstead (40) have performed partial extirpations of the thymus and report favorable and in some instances remarkable curative results. Nevertheless the experimental ground work is lacking and the relations of the thymus and thyroid in this disease and in the healthy economy also are obscure. It would seem that the thymus overgrowth is but one feature of the general lymphoid hyperplasia, which probably represents a reaction to the disturbed metabolism in this disease. A solution of the problem however must await a more precise knowledge of the chemical functions of the lymphoid cells.

Equally unclear is the significance of the thymic hyperplasia frequently observed in acromegaly and in Addison's disease. Experimental efforts to show a clear cut relation between thymus and adrenals have led to nothing definite. In a large series of thymectomized rats both chromaffin tissue and cortex were found to be present in normal amount.

#### X. RELATION OF THE THYMUS TO GONADS

I have left to the last the proper subject of my review the relation of the thymus to the sexual organs. The facts may be very briefly given. Most of the experimental observations for obvious reasons have been based upon study of the male gonads in which the presence of spermatogenesis gives a sharply defined criterion of maturity.

First, as to the influence of thymectomy upon the development of the sexual organs. The literature on this as on most other phases of thymus physiology is contradictory. Paton (41) in guinea pigs found that removal of the thymus was followed by increase in the average weight of the testis amounting in one series, to 46 per cent. Yule (42) however later analyzed these figures by statistical methods, and showed that Paton's results might be due to chance variation. Furthermore, Hulsan and Marshall (42) in a large series obtained no such effect, and Soli (43) in chickens, rabbits and guinea pigs,

found the testicles in the thymectomized animals smaller than in the controls and spermatogenesis retarded or absent. Lucien and Parisot (44) also found a transient delay in the development of the testes. Klose and Vogt, in their dogs observed a transient hyperplasia of the testicles followed by atrophy in the cachectic stage. Matti was unable to determine any relation between thymectomy and the onset of spermatogenesis.

The following table which is based on a study of a small number of thymectomized and control rats indicates no decisive influence of thymectomy upon spermatogenesis or total weight of the testicles.

Rat	Age	Operation	Wt. of Testicles	Size of Testicles	Spermatogenesis
A5	45	Thymectomy		4.3	No spermatogenesis
A4	45	Thymectomy*			N spermatogenesis
A6	45	Control		6.5	N spermatogenesis
					More mitotic figures than A5 and A4
B	58	Thymectomy*	5		Spermatogenesis
B4	58	Thymectomy*	45		Spermatogenesis
B6	58	Control	30		Spermatogenesis
E2	68	Thymectomy*		6	Active spermatogenesis
E3	68	Thymectomy*			N spermatogenesis
O1	40	Thymectomy*	450		Active spermatogenesis
O2	40	Control	475		Active spermatogenesis
O3	40	Control	664		Active spermatogenesis
S4	104	Thymectomy*	30		Fairly active spermatogenesis
S6	04	Control	603		Fairly active spermatogenesis
I	79	Thymectomy*	80		N spermatogenesis
II	79	Control	206		N spermatogenesis

\*Incomplete castration.

\*Complete castration.

I have found but one reference to the condition of the ovaries after thymectomy. Valtortu (45) 1909 states that removal of the thymus in rabbits is followed by degenerative changes in the ovary, namely a scarcity of primitive follicles in the outer zone and regressive changes in the follicles in the inner zone. These alterations which made the ovaries functionally insufficient were regarded as merely accompanying the general malnutrition of his animals.

Hewer (46) has recently attempted to

demonstrate a reciprocal relationship between thymus and gonads by the use of the X rays. She found that irradiation of the thymus region alone was followed by degenerative changes in the testes with delay in the time when copulation was begun. The ovaries were not structurally affected. On the other hand irradiation of the gonads was followed by alterations in the structure of the thymus, namely the appearance of Hassall bodies which according to her are not normally found in the rat thymus.

Without attempting here a detailed analysis of this work one may bring forward certain obvious criticisms. Only small series of animals were studied and the controls were conspicuously few. The appearance of Hassall bodies after irradiation of the testes upon which much emphasis is laid is of doubtful significance. Hypertrophic cell complexes and occasional fully concentrically structured Hassall bodies occur though sparingly in the normal rat thymus. Furthermore glands are described as hypertrophic, atrophic, and normal without giving weights or comparisons with controls. It does not appear to the writer that conclusions can be drawn from the data presented in view of the normal wide variations.

Much greater certainty exists as regards the effect of early castration upon the thymus and the numerous experiments of Henderson (47) Goodall and Paton (48) Calzolari (49) Ranzl and Tandler (50) Gellin (51) Halnan and Marshall (42) are in substantial accord. There occurs regularly following removal of the gonads before sexual maturity a much delayed involution of the thymus so that the glands are enlarged in comparison with non-castrated controls of the same age. Valtortu found the same thing to occur after removal of the ovaries in young rabbits. His experiments however were not adequately controlled.

Nothing definite is known as to the possible mechanism which controls this relationship. It may be said however that in general the development of the thymus and the lymphatic tissue runs parallel to the general nutrition. Healthy well fed animals have large glands, diseased ill nourished ones have atrophic



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## THE ENDOCRINE FUNCTION OF THE PANCREAS AND ITS RELATION TO THE SEX LIFE OF WOMEN

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IN 1889 von Mering and Minkowski discovered that complete extirpation of the pancreas in the dog produces fatal diabetes. This has been abundantly confirmed on all species of vertebrates so far investigated. The attempts of Pflueger and others to show that the diabetes following removal of the pancreas is due not to the absence of the pancreas, but to injury to the duodenum and nerves connecting the pancreas with the rest of the viscera must be considered a failure. The original conclusion of von Mering and Minkowski is definitely established: the complete or nearly complete loss of the pancreas results in fatal diabetes. The more recent investigations

of the condition of the pancreas in clinical diabetes (Ssobolew, Opie, Visentini and others) have shown that in severe diabetes or in deaths in diabetes there is usually more or less degeneration of the pancreas especially in the island tissue. The conclusion that the pancreas is absolutely essential to life and to carbohydrate metabolism is thus based both on experimental and clinical data. This conclusion is established beyond a doubt.

### I THE ISLANDS OF LANGERHANS

The part of the pancreas concerned in this function appears to be essentially the islands of Langerhans. This seems to be

demonstrated by the following facts (1) Loss of the external pancreatic secretion (by permanent fistula of the pancreatic ducts) does not induce diabetes. (2) Ligation of all the pancreatic ducts leads ultimately to complete degeneration of all the pancreas tissue except the islands of Langerhans at least in animals like the rabbit and guinea pig. Such animals with only islets do not develop diabetes unless these remnants of the pancreas are extirpated. (3) In clinical diabetes the pancreas lesions usually involve the islets. Despite these facts the view that the entire pancreas tissue is concerned in the maintenance of the capacity of the tissues to oxidize the carbohydrates is still maintained by some clinicians and biologists (cf Lombroso). This view finds its strongest support in the fact that human diabetes may reach a fatal issue while there still remains an abundance of apparently normal island tissue in the pancreas as determined histologically. It is possible however that normal function is reduced or lost before anatomical or chemical degeneration of the cells reach such magnitude that they can be detected by the microscope. This theory of identity of the function of the entire pancreas was also supported by the work of Dale Vincent and Thomson and others which appeared to show that the islets represented only stages of fatigue or rest of the ordinary pancreas tissue. Laguesse Bensley and others have shown that this is untenable. While the islets and acini develop from the same embryologicalanlage (the cells of the ducts) when finally differentiated they show constant and specific structural and chemical characteristics, evidently indicating specificity of function. And there is no foundation for the view that the one tissue is or can be transformed into the other.

The number and size of the islets vary greatly in different species, as well as in individuals of the same species. In some fishes they are macroscopic (5x14 mm). In man the islets have been estimated to make up one twenty-fifth to one hundredth part of the entire pancreas tissue or a total of 2 or 3 grams. In normal animals (dog) five sixths of the total pancreas can be removed without inducing diabetes, so that the factor of safety is very great. The total number of islands in mammals appears

to be fixed at or rather before birth (Bensley). The island tissue is made up of two distinct types of cells, showing specific staining reactions, a less abundant alpha type, and a more numerous beta type (Lane and Bensley). According to Homans it is the beta cells that show degenerative changes in diabetes.

The islets develop from the undifferentiated duct cells and may or may not retain this original connection with the ducts, but in either case the blood supply of the islets is greater than to the rest of the pancreas tissue. In this respect the islets resemble the adrenals and the thyroids. In fact blood supplies similar to those of the adrenals have been described in the islets (DeWitt).

The islets are also abundantly supplied with nerve fibers. Groups of ganglion cells are also distributed in the body of the pancreas. The function of the nerves distributed to the islets are unknown. Some of them are undoubtedly vasomotor nerves, but others form a network between or around the islet cells which appears to indicate a secretory or reflex function.

## II. EXPERIMENTAL PANCREATIC DIABETES

Extirpation of the whole or more than six sevenths of the pancreas leads to fatal diabetes in all animals. In birds pancreaticotomy leads to hyperglycemia and death, but there is said to be little or no glycosuria, because of the relative impermeability of the renal epithelium of birds to sugar. Following the fundamental discovery of pancreatic diabetes by von Mering and Minkowski in 1889 a tremendous amount of work has been done to elucidate the nature or mechanism of this diabetes (cf Allen 1914). The following facts are established:

1. Hyperglycemia and glycosuria appear within a few hours after pancreatectomy and, together with polyuria and polydipsia, persist till shortly before death even when no food is given. If the hyperglycemia of clinical or experimental diabetes is sufficiently marked the sugar appears in the saliva, gastric and pancreatic juice and in the bile.

2. The liver and the muscles become practically free from glycogen, but the essential factor appears not to be the inability to store glycogen (alimentary glycosuria) but a greatly diminished capacity of the muscles to utilize the sugar. The respiratory quotient is therefore low. Nishit states that perfusion of the liver of pancreatectomized turtles with Ringer-glucose solution leads to some storage of glycogen in the liver cells.

3. There is marked polyphagia and generally a striking increase (15 to 20 per cent) in the total metabolism per unit of body weight. There is no rise in the respiratory quotient after giving glucose or

fructose. The increased excretion of the acetone bodies parallels the increase in the D.N. (dextrose nitrogen) ratio.

4. There is a tendency to uræmia and usually some acidosis and ketonuria, but these symptoms of diabetes are, at least in the dog not as marked as in clinical diabetes, and the completely pancreatized animals die apparently from extreme inanition or from intercurrent infections rather than in diabetic coma due to acidosis.

5. When the pancreas remnant is too small to maintain normal sugar tolerance and metabolism, the pancreas rest is more likely to undergo gradual atrophy than to show hypertrophy with the end result of absolute and fatal diabetes (Sandmeyer). The incomplete diabetes in animals following extirpation of more than 85 per cent of the pancreas can apparently be intensified and the appearance of complete diabetes and death hastened by a liberal carbohydrate diet (Thirlokz, Allen).

6. Complete pancreatectomy leads to death in 3 to 6 weeks in the case of dogs irrespective of the age of the animal while diabetes mellitus is usually more rapidly fatal in children than in adults and old people.

7. The persistent hyperglycæmia and glycosuria and the low respiratory quotient show that the pancreatized animal burns practically no sugar yet the study of the sugar oxidation capacity of the blood and of individual tissues like the skeletal muscles, and the heart have so far revealed no difference between the normal and the diabetic animal (Claus and Embden, MacLean, McGuigan, Patterson and Starling, Macleod and Pearce). The respiratory quotient of the dog's heart averages 0.71 irrespective whether the heart is that of a diabetic or a normal dog (Starling and Evans).

Certain other features of experimental pancreatic diabetes may be noted. Epstein and Bachu claim that there is an increase in the blood volume (plasma) in dogs and cats after pancreatectomy irrespective whether the animal is fed. Hoskins and Gunning state that in dogs after complete pancreatectomy the blood pressure remains either normal or somewhat depressed. Reaction to adrenalin is usually augmented to nicotine variable but usually depressed. There is no evidence that the pancreas normally exerts a depressive action on the sympathetic nervous system. They found no evidence of increase in the adrenalin content of the adrenals after pancreatectomy. There is some increase in the amount of fat in the blood.

Verzar and Fejer claim that administration of glucose during the first three or four days after pancreatectomy raises the respiratory quotient. This, if true, would indicate that the pancreas hor-

more persists in the blood and the tissues for several days. This is improbable. It must be remembered however that all the sugar of the food or from the endogenous protein metabolism does not appear in the urine even in animals and patients showing the D.N. ratio of 3.65 to 1 which Lusk has designated as the index of absolute diabetes. It is not known what becomes of the retained sugar. In diabetic patients the respiratory quotient fails to account for all the carbohydrates that disappear in the body (Allen and DuBois).

Attempts have been made to explain the glycosuria of diabetes by the increased rate of liberation of the sugar from some hypothetical sugar + protein or sugar + colloid combinations in the blood. The recent dialysis experiments of Van Hoes and McGuigan seem to indicate that all the sugar in the blood is present in simple solution that is in free form but more recently McGuigan has come out in support of the theory of Lepine, namely that part of the blood sugar is normally in a polysaccharide state.

The carbohydrate tolerance varies greatly in different species. It is very low in the pig and the sheep (Carlson and Drennan, Hunter and Hill). In normal persons 400 to 500 grams of glucose may be given by mouth without inducing polyuria or glycosuria (Taylor and Hilton). In normal men and animals the oxidation of sugar is increased in proportion to the quantity of sugar given intravenously up to a very high limit (Wood yatt).

The endeavor to determine how absence of the pancreas causes diabetes is practically a record of repeated failures. The leading idea in all this work has been the internal secretion theory or that the pancreas yields some substance to the blood in some way necessary for the oxidation of the sugar by the tissue cells. But in the absence of conclusive demonstration of internal secretion the possibility that the work of the pancreas in maintaining normal sugar metabolism consists of detoxication processes must always be kept in view. The fact that even temporary glycosuria is not induced in normal animals by diabetic blood does not render the detoxication hypothesis untenable.

The method of nitack introduced by Cohnheim has not yielded consistent results (Claus and Emb-

den, McGuigan) In the light of the findings of Levene and Mayer the method itself is called in question, as it appears that in a mixture of muscle extract and pancreas extract glucose is polymerized not oxidized. No light on pancreatic diabetes has so far been shed by studying the sugar oxidizing power of tissue debris or tissue extracts.

#### A ATTEMPTS TO CONTROL EXPERIMENTAL DIABETES

1 *Feeding pancreas or pancreas extracts* Feeding dogs in complete or partial pancreatic diabetes with fresh pancreas increases the glycosuria and acidosis (Sandmeyer Pfleger Luthje Beach Rosenberg Kirk) Cooked pancreas gives negative results Feeding of raw muscle liver or other tissue extracts have the same unfavorable influence on the glycosuria and ketonuria Ausset and particularly Pratt Spooner and Murphy report good effects from feeding pancreas in partially diabetic dogs but the improvement in the carbohydrate tolerance was slight, variable and practically negligible

According to Massaglia feeding pancreas extract to guinea pigs with experimental reduction of the pancreas reduces or prevents the alimentary glycosuria following carbohydrate food He advocates the use of pancreas extract in mild cases of human diabetes

2 *Injection of pancreas extracts* Subcutaneous or intraperitoneal injections of extracts of the pancreas variously prepared may cause a temporary diminution of the glycosuria in diabetic animals (Caparelli, Vanni Tiberti and Fanchetti Minkowski, Hedon Scott Allen Murlin and Kramer and others) But this temporary diminution of the output of sugar in the urine is associated with the toxic effects of these extracts such as depression fever etc and McGuigan has recently shown that anything which causes marked systemic depression (such as injection of proteoses) leads to hypoglycemia and will thus temporarily diminish glycosuria. If present. Thus Underhill reports diminution of glycosuria in dogs by hydraxine The after effects of pancreas extracts given to diabetic animals are a general increase in the glycosuria and ketonuria (Leschke) Knowlton and Starling and MacLean and Smedly reported that the sugar oxidation of the heart from

a diabetic animal is almost nil, and in any event much less than that of a heart from a normal animal But further work has shown these results to be due to faulty technique (Interson and Starling) Extracts of the pancreas added to the perfusion solution has no effect on the respiratory quotient of the diabetic heart (Starling and Evans) There is no evidence that any extract of the pancreas so far prepared has increased the power of a diabetic animal or patient to oxidize sugar

3 *Blood transfusion* If the pancreas controls the oxidation of sugar in the tissue by a hormone or hormones these must be present in the blood and unless they are extremely unstable or present in very minute traces, it should be possible to increase temporarily the sugar oxidation in diabetic animals and patients by transfusion of normal blood in sufficient quantities But the results obtained by this method are both conflicting and difficult to interpret.

Lepine reports a temporary diminution in the output of a sugar in the urine, but no diminution in the blood sugar This would seem to point to some

funous action of the foreign blood on the kidneys a suggestion also advanced by Hedon, but Rabens has shown that transfusion of normal blood into diabetic dogs does not influence the output of any of the urinary constituents except the sugar Hess injected intravenously 30 to 150 cubic centimeters of blood from diabetic dogs into normal dogs (on the theory that a diabetic blood might stimulate the pancreas to a greater output of internal secretion) and nine to fourteen hours later he injected the serum from this animal into diabetic dogs The influence on the glycosuria of the diabetic animal was slight or nonconstant In view of the results of Drennan it seems likely that in the experiments of Hess the pancreas hormone in the blood was destroyed by the delay in centrifuging the blood Alexander and Ehrmann injected blood from the pancreaticoduodenal vein of normal dogs in diabetic dogs, but obtained no definite or constant decrease of the glycosuria.

Drennan injected 50 to 150 cubic centimeters of fresh defibrinated dog blood into the veins of diabetic dogs and invariably obtained a temporary lowering of the urine sugar and D.N. ratio. Defibrinated sterile blood loses this action on standing for a few hours The course of the blood sugar in the injected animals was not studied Hedon has reported a very extensive series of blood transfusion in diabetic dogs Direct transfusion from a normal dog into a diabetic dog previously bled dry causes a temporary lowering of the blood sugar and de-

crease or complete suppression of the glycosuria, but since the same results were produced when blood from a diabetic dog was transfused into another diabetic dog Hedon concludes that the temporary diminution of the hyperglycemia and glycosuria following the transfusion were not due to any specific pancreas secretion in the blood but to a lowering of the blood sugar by dilution and to a toxic action of the foreign blood on the kidneys. Hedon concludes that the internal secretion of the pancreas acts on and is absorbed by the liver and is therefore not present in the blood of the systemic circulation. Hedon attempted to obtain evidence in support of this view by introducing a living pancreas in the systemic and in the portal circulation of diabetic dogs. With the living pancreas interposed in the portal circulation the hyperglycemia and glycosuria were diminished, but interposed in the general circulation the pancreas had no effect. We do not think that these later results of Hedon can be accepted, in view of what is known concerning the carbohydrate metabolism in dogs with Eck fistula. In the animal with the Eck fistula the internal secretion of the pancreas if there is one, must pass into the general circulation, and only a small part of it can reach the liver by way of the hepatic artery just as in Hedon's diabetic dogs with the living pancreas from another dog interposed in the general circulation yet the Eck fistula dog does not develop diabetes.

Murlin and Kramer have recently reported one experiment with transfusion of normal blood into a diabetic dog using the respiratory quotient as a measure of sugar oxidation. The average respiratory quotient for two one-hour periods before the transfusion was 0.678 for four one-half hour periods after transfusion 0.700. No conclusion can be based on the result of a single experiment but so far as they go in this case the transfusion raised the respiratory quotient.

Carlson and Ginsburg found that the transfusion of normal blood into dogs in complete pancreatic diabetes without anesthesia or previous hemorrhage causes a temporary (4 to 8 hours) lowering of the hyperglycemia and the glycosuria. Similar transfusions of diabetic blood into diabetic dogs have no effect on the hyperglycemia. There was no indication in our results that the sugar retained by the animal in consequence of this temporary lowering of the sugar excretion by the kidneys is subsequently eliminated by the kidneys as an excess sugar.

The blood transfusion as such does not impair the activity of the kidneys in any demonstrable way either in diabetic or in normal dogs. The temporary lowering of the glycosuria of pancreatic diabetes by transfusion of normal blood is due to the diminished hyperglycemia not to kidney injury but it remains to be demonstrated that this retained sugar is actually oxidized by the tissues. The sugar might be eliminated into the digestive secretions and destroyed by the bacteria of the digestive tract.

*Perfusing the living heart (dog)* With Locke's solution previously perfused through a living pancreas A. H. Clark has recently reported a series of experiments which seem to indicate that the living pancreas yields a substance (ferment) to the Locke's solution which enables the heart to oxidize as well as to condense the dextrose of the perfusion fluid. This pancreatic substance is destroyed by boiling and quickly loses the activity on standing as previously reported by Drennan.

**4 Parabiosis** Experimental symbiosis or parabiosis of two mammals is accomplished usually by union of the skin and abdominal walls of two sisters or brothers. It was originally thought that such a union of two animals would lead to a direct vascular connection between the two but it is now known that this is not the case. There is no fusion of the capillary system of the two animals in the region of the tissue union. But the capillary system of the two animals are in such close contact that chemical substances injected into one animal soon appear in the blood of the other animal. On the basis of this fact one may reasonably expect that the blood hormones of one animal would find their way into the body fluids of the other animal.

On this theory Forsbach extirpated the pancreas in one member of two such parabiotic pairs (dogs). In each case a slight temporary glycosuria appeared in both animals. But because of accidents both experiments were terminated before definite results were obtained.

**5 Pregnancy** It was shown by Pearce that the islets of the pancreas appear early in fetal life. No diabetes or glycosuria appears in human infants born two or even three months before term. This would seem to show that the pancreas hormones become of functional importance to the fetus a considerable time before the end of gestation. On the basis of these facts Carlson, Drennan, Orr and Ginsburg made complete pancreatectomy in pregnant bitches near term. *In all cases where the operation is not followed by abortion the blood sugar and the urine remain normal until the pups are born or removed by cesarean section.* Complete pancreatectomy in bitches in early pregnancy leads to abortion or at least to death of the fetus in one or



two weeks and the course of the diabetes is not influenced.

This absence of diabetes may be due either to the pancreas hormones of the fetuses passing into the mother's blood or to some detoxicating action on the part of the fetal pancreas.

There is a seeming discrepancy between these results on pregnant dogs and the usual clinical experience on the effects of pregnancy on the course of diabetes in women. The clinical reports are nearly unanimous on the point that pregnancy augments the diabetic symptoms and hence the practice to terminate the gestation in diabetic mother. But Fahner reports a case in which the diabetes (glycosuria?) of 2 or 3 years standing diminished to almost complete disappearance of sugar from the urine during a pregnancy and the diabetes reappeared in its original severity shortly after the delivery of a full term but stillborn child. Fellner suggests that the glycosuria of pregnancy is due to the action of the ovaries (hormones) on the liver, the pancreas and the thyroid.

**6 Transplantation of the pancreas.** Most of the transplantations of the pancreas have been mere dislocation of a portion of it, the usual method being the transplantation of the tail of the pancreas with its circulation intact to other parts of the abdominal cavity or even under the skin of the abdomen. If a sufficient quantity of the pancreas is thus dislocated or thus transferred, and care is taken to retain the circulation in good condition at least for a time the remainder of the pancreas may be extirpated without inducing diabetes (Therolox, Hedon Lombroso Minowski). But in most cases even these transplants show a tendency to atrophy with a gradual onset of diabetes and ultimate death in complete diabetes. The external ferments of the pancreas are probably responsible for this gradual necrosis of the graft. There is no record in the literature of transplantation of pure island tissue. There is certainly greater hope of success with such tissue than with the entire pancreas. Pflueger failed to influence the diabetes of depancreatized frogs by inserting pieces of the pancreas under the skin or in the peritoneum. Pratt reports

the case of one pancreas transplant into the spleen (dog) that retained its function (absence of diabetes) for six months.

### III THE RELATION OF PANCREATIC DIABETES IN ANIMALS TO CLINICAL DIABETES

In their essential features experimental and clinical diabetes are practically identical. There is the same impairment of power to burn sugar, the identical hyperglycemia, tendency to acidosis, lowered resistance to infection, polyphagia, etc. The two types of diabetes are influenced in the same direction by dietetic and therapeutic measures (Allen). All the evidence points to the view that actual diabetes mellitus in man is primarily due to deficiency in pancreatic hormones. This does not apply to the various glycosurias (adrenalin, nervous, alimentary, postoperative, etc.) that do not involve impairment of sugar oxidation.

The main points of difference between experimental diabetes in animals like the dog and clinical diabetes mellitus in man are a lower D/V ratio and a greater increase of total metabolism, less acidosis and an increase of total metabolism in experimental diabetes, together with the fact that human diabetes frequently ends with death before there is any pronounced degeneration in the island tissue, as determined by histological methods. It would seem that in the absence of intercurrent infections, the human diabetic patient dies from acidosis, the dog with complete loss of the pancreas dies from extreme inanition.

### IV ADMINISTRATION OF PANCREAS PREPARATION IN CLINICAL DIABETES

**1 Administrations of pancreas preparations by the mouth.** Some of the earliest attempts to treat diabetes mellitus organotherapeutically were by the administration of the pancreas by the mouth. It was early largely abandoned for the results were practically negative (Mackenzie, Wood, White, de Cereville, Willis, Williams, Rennee and Fraser, Pratt, Wood, Marshall).

A few writers (Wegede, Meyer, Cowles, Eustis) have reported favorable results. Some of these reports contain only impressions; in others the glycosuria seemed dependent upon an infection, and varied so much in severity that it is difficult to determine the effect the treatment had. In Cowles' case the diabetes had followed an abscess of the pancreas; marked and rapid improvement is stated.

to have followed the eating of one to six raw pancreases of calves daily after discontinuing the treatment the patient became rapidly worse and died.

Rennet and Fraser administered the islands of Langerhans obtained from fish of certain species in which they occur separately i.e. distinct from the pancreas proper to a number of diabetics the results were negative.

Sewall found in the earlier stages of one case of youthful diabetes that the urine could be made free of sugar by the administration by mouth of infusions of raw lean beef followed after some hours by one of pancreas neither alone was efficacious and after some months the combined treatment failed. The method was ineffective in a number of other cases. No good results attended the use of the commercial pancreatic powder.

Under the influence of the first report of Knowlton and Starling on the effect of pancreas extract on the sugar consumption of the diabetic heart Eustis administered 10 to 20 grains of an active extract of the pancreas every four hours on an empty stomach in four cases of diabetes. He reports diminution of the glycosuria in two of the patients and no effect in the others.

There is, however according to Falta a small group of cases of human diabetes in which the administration of pancreas by the mouth give good results *this is the result of supplying the external and not the internal secretion of the gland*. Falta refers to those cases in which the pancreas is diseased so that there is no longer an adequate secretion of pancreatic juice into the intestine this occurs most frequently when lithiasis causes complete obstruction of the pancreatic duct. In such cases Falta states that the administration of large doses (10 grams daily) of pancreatin gives excellent results calcium carbonate is given at the same time.

2 *Subcutaneous and intravenous injections of pancreas preparations*. A number of attempts have been made to treat diabetes by subcutaneous and intraperitoneal injections of extracts of pancreas, with negative or injurious results. The favorable results reported by some of the earlier clinicians were shown by Pflieger and Leschke to be wholly inconclusive. The more recent attempt of Zuelzer to treat the disease by the intravenous injection of a pancreas hormone was shown by von Fuerth and Schwarz to be based upon a very unsatisfactory theory and by Forschbach to be positively dangerous.

Gilbert and Carnot and von Noorden have

attempted to control diabetes mellitus with administration of liver preparations.

*Blood transfusions*. Raulston and Woodruff appear to have been the first to try blood transfusion as a practical therapeutic measure in man. The patient was a man in the thirties the diabetes of several years standing with periods of threatening coma. The blood (500 cubic centimeters) was yielded by a two-year older brother of the patient. The experiment was well controlled. *The blood transfusion augmented all the diabetic symptoms for several days following the operation*.

#### V THE RELATION OF OTHER ENDOCRINE GLANDS AND ORGANS TO EXPERIMENTAL AND CLINICAL DIABETES

In 1908 Eppinger Falta and Rudinger advanced the theory that diabetes is not due primarily to the hypofunction of any one endocrine gland (e.g. the pancreas) but to a disturbance of the hormone equilibrium of all the glands particularly that of the pancreas thyroid adrenals and hypophysis. The specific influence on carbohydrate metabolism of hypo- and hyperfunction of the adrenals thyroid and hypophysis will be discussed in the articles dealing with these glands. It now remains to consider whether the hypo- or hyperfunction of any other organ beside the pancreas are capable of so reducing the capacities of the tissues to oxidize sugar that true diabetes follows. A critical analysis of the entire literature experimental and clinical, seems to warrant the following conclusions.

1 Hypo-activity of the thyroid, the hypophysis and the gonads may slightly increase carbohydrate tolerance although further studies should be made on this question by more accurate methods of measuring sugar oxidizing capacity. This may be in reality a thyroid factor as there is some indication of hypertrophy of the islets, at least after thyroidectomy.

2 Excessive administration of epinephrin thyroid extract and possibly hypophyseal extract may induce temporary hyperglycemia and glycosuria, due to increased sugar mobilization. But there is no evidence that this glycosuria is or passes into true diabetes that is, lowered power to burn sugar in the absence of a direct pancreas depression. This applies also to disturbances of the nervous system.

3 The specific influence of the hypo- or hyperactivity of the adrenals thyroid and hypophysis on

the islets of the pancreas cannot at present be definitely formulated, but it is obvious that organs as necessary to life or to normal life as the parathyroids, the adrenals, the hypophysis, and the thyroid will affect the vital processes of the islet tissue, at least indirectly through the general disturbance of metabolism and the circulation.

After a careful experimental and critical review of the entire question Allen stated recently that the *polyglandular equilibrium doctrine of diabetes has consisted from the first of ingenious but unfounded speculations*. We are in entire accord with this conclusion.

The attempt of Pflueger to show that diabetes is due not to hypofunction or loss of the pancreas but to interference of nervous reflexes from the pancreas to the duodenum and the liver has already been referred to. Any general reflex theory of diabetes is untenable in view of the fact that every organ so investigated continues to oxidize sugar after complete denervation. The loss of the capacity to burn or to synthesize carbohydrates is essentially a hormone disturbance not a reflex disturbance.

Other workers have pointed to the probable importance direct or indirect of the gastro-intestinal tract in diabetes. Case has recently reported a striking parallel between the severity of clinical diabetes and the degree of ilial stasis. If the ilial stasis is a primary factor this would point to intestinal intoxication depressing the pancreas as a contributory factor in diabetes.

The administration of sodium carbonate reduces temporarily the glycosuria of depancreatized dogs. This fact has led Murlin to suggest that the diabetes following extirpation of the pancreas may be due, in part, to the unneutralized hydrochloric acid of the stomach secretion. Murlin and Sweet have removed the stomach in depancreatized dogs, and find that the glycosuria is less severe than with the stomach intact. But such animals are probably more depressed than cases of simple pancreatectomy and the low output of sugar may be due to this condition.

#### VI. THE RELATION OF THE PANCREAS TO THE SEX LIFE OF WOMEN

1. *Diabetes and menstruation* Diabetes tends to produce impotence and loss of the sex urge both in men and women. In women diabetes of marked severity causes amenorrhea, sterility, premature menopause, and atrophy of the uterus. In general the depres-

sion of the sex life is proportional to the severity of the diabetes. Von Noorden states that menstruation in diabetic women is variable. It may be normal, but is usually decreased. In some women amenorrhea may set in early in diabetes while in others menstruation may persist until late stages of the disease. The same author states that the sexual desire is usually decreased in diabetes, but in elderly women it may be temporarily increased.

These changes in the sex life of women by the diabetic condition are probably due to impairment of tissue oxidation and not to a direct or specific relation of the pancreatic islets to the gonads. At any rate there is no distinct influence of gonadectomy on the pancreas. Marshall's review of the literature shows that there is no constant reduction in the total metabolism, or change in tissue oxidation after castration and spaying. Stolper claims however that 25 grams of dextrose given by mouth causes glycosuria in spayed rabbits but not in normal rabbits.

2. *Diabetes and pregnancy* Statistics seem to show that diabetes is more frequent in men than in women. Diabetes is also more frequent in people past forty years of age. We have seen that diabetes tends to suppress sex life. These facts operate to render pregnancy in diabetic women a relatively rare phenomenon. Nevertheless, many cases of pregnancy in partially diabetic women have been recorded. By the law of chance, we should expect occasional cases of diabetes developing during pregnancy irrespective of the influence of pregnancy on the pancreas.

a. *The glycosuria of pregnancy* All clinical workers agree that glucose frequently (1 to 4 per cent) appears in the urine of pregnant women, otherwise normal, especially toward the end of gestation. Bayer and Reichenstein report that 30 to 80 per cent of pregnant women show an alimentary glycosuria after receiving only 100 grams of glucose by mouth. This seems to indicate a lowered sugar tolerance in pregnancy that may be due to impairment of the pancreatic islets. Bayer's conclusions are questioned by Scherokauer. The question of sugar tolerance in pregnancy should be settled definitely by the more ac-

curate method of Woodyatt Veit thinks that the glycosuria of pregnancy is due to liver injury from the absorption of placental material. Veit's conclusion is based in part on animal experiments. The glycosuria of pregnancy has also been ascribed to an alleged excess of epinephrin in the blood. Others have pointed to nervous or emotional factors to excess activity of the thyroid the hypophysis etc. Allen thinks that the slight intoxication of pregnancy is probably the cause of the glycosuria, but he does not indicate on what organs the pregnancy toxin acts. According to Scherokauer the blood sugar remains practically normal in pregnancy. Fellner suggests that the glycosuria of pregnancy is due to the action of the ovaries (hormone) on the liver the pancreas, and the thyroid. The condition is of little practical importance. The primary involvement of the pancreas in the pregnancy glycosuria has not been established.

*b Pregnancy and diabetes* The earlier observers were practically agreed (1) that pregnancy aggravates an existing diabetes in the mother and (2) that diabetes in the mother has a very deleterious influence on the foetus.

The deleterious influence of pregnancy on the course of the diabetes in the mother is more marked in the young than in the older mothers (Geel muyden). Hydramnios is a frequent complication. Unless the pregnant and diabetic woman is given special dietetic care a large percentage (25 per cent to 33 per cent) of such women develop diabetic coma shortly after delivery (Offergeld). Premature births or abortion due to death of the foetus puerperal infection etc. are frequent.

The generally accepted view that pregnancy aggravates diabetes was questioned by Neuman in 1909 and still more recently by the work of Joslin. Neuman reports severely diabetic women carried through to normal delivery of healthy children and normal lactation by dietary measures. Joslin thinks that the usual aggravation of diabetes by pregnancy is due to the greater ingestion of food. He has shown that pregnancy can be carried to full term (with a normal healthy child) in partially diabetic mothers by careful regulation of the mother's diet (Allen treatment).

Hence it is still an open question whether the condition of normal pregnancy necessarily aggravates the existing diabetes in the mother and there is no evidence that preg-

nancy can induce diabetes in a non diabetic woman. *A priori* one would expect the stress (nervous and metabolic) of pregnancy to involve the pancreas and sugar metabolism. But this fundamental question evidently must be determined by experiment.

*c The influence of the diabetic condition of the mother on the fetus* Fellner Fruhnholz and others state that 50 per cent of the foetuses of diabetic mothers are stillborn or so feeble that they die a short time after delivery. There is no evidence that the child of a diabetic mother is born a diabetic. The weakened condition must therefore be due to the acidosis and other disturbances of the mother. When these are controlled by dieting the partially diabetic mother is apparently able to give birth to a child normal (Neuman Joslin) except for a possible hereditary tendency to diabetes in later life. But this is true only in cases of partial diabetes. I am convinced that absolute diabetes (complete loss of pancreatic islets) is incompatible with pregnancy. In such condition the foetus cannot be nourished so that death and abortion is unavoidable. But this condition is never seen in medical practice as a completely diabetic woman probably cannot conceive.

*3 Other conditions of female sex life possibly related to pancreas function* Glycosuria may occur associated with the disturbances of adolescence. This is probably of nervous origin and not a direct involvement of the pancreatic islets.

In *osteomalacia* a malady in some way related to ovarian function the adrenalin glycosuria is diminished according to Christofolletti and others. This is probably due to some change in the irritability of the sympathetic nervous system rather than to any change in the pancreas.

In *chlorosis* the carbohydrate tolerance is either normal or slightly greater than normal (von Noorden).

*Acetonuria of labor* For a few days following delivery there is an increase of the acetone bodies in the urine the acetonuria being more marked the more difficult the labor (Couvclaure and Scholten). This condition is probably due to too rapid tissue destruction or possibly to a temporary impairment of oxidation

There is no evidence that the pancreas is primarily concerned

**Puerperal lactosuria.** In a small percentage of women trace of lactose appear in the urine at the beginning of lactation. This is evidently due to passage of lactose from the mammary gland into the blood. It is not diabetes and does not indicate any involvement of the pancreas.

**Pituitary extract and sugar tolerance.** Cushing is a firm exponent of the view that posterior lobe extract causes hyperglycemia and glycosuria. Falta on the other hand claims that the extract induces hypoglycemia by increasing the sugar oxidation in the tissues. There is probably no involvement of the endocrine function of the pancreas in the use of pituitary extract as employed in gynecological practice.

#### VII SUMMARY

1 All evidence supports the view that some substance or hormone secreted by the islands of Langerhans into the blood is necessary for utilization of sugar by the tissues. This function is specific for the pancreas. Other endocrine organs may influence sugar metabolism in a superficial way by altering the sugar mobilization (adrenals thyroid) or by increasing or decreasing the rate of oxidation in the body in general. The rest of the endocrine glands cannot maintain the power of the tissues to oxidize sugar in the absence of the pancreas, and the hypo- or hyperactivity of other endocrine glands do not produce actual diabetes in the presence of a normal pancreas.

2 While the failure of the tissues to use sugar in the absence of the pancreas is the central and definitely established fact there are probably other primary defects involved in the development of acidosis, hypæmia, increased metabolism, lowered resistance to infections, etc.

3 All the evidence points to the view that true diabetes mellitus in man is primarily the result of pancreatic deficiency (islets).

4 There is, at present, no organotherapy of diabetes experimental or clinical.

5 There is at present no evidence of any specific relations of the endocrine functions of the pancreas to the gonads male or female

or to menstruation pregnancy and lactation. Absolute diabetes induced after conception, leads to death of the foetus. Absolute diabetes probably renders conception impossible. Partial diabetes under careful dietary control permits of normal sex life of women (menstruation normal pregnancy normal child, lactation) and pregnancy under such conditions does not aggravate the diabetes. But in the absence of such dietary control the condition of pregnancy aggravates the diabetes in the mother and uncontrolled diabetes in the mother is extremely injurious to the foetus. There is some evidence that in late stages of pregnancy the foetal pancreas may function for the mother.

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# THE EXPERIMENTAL AND CLINICAL EVIDENCE AS TO THE INFLUENCE EXERTED BY THE ADRENAL BODIES UPON THE GENITAL SYSTEM

BY SWALE VINCENT M.D., WOODBURY MANITOWA

**D**URING the last twenty five years there has been a great change in our current views about the adrenal bodies.

By no means the least important department of investigation has been the comparative anatomy of these bodies and it may be stated that our knowledge in this regard so far as concerns vertebrate animals seems fairly complete. This knowledge it must be confessed even when combined with the results of very numerous physiological investigations, has by no means answered the question: What is the function or what are the functions of the adrenal bodies? but it has made clear what we mean when we refer to these organs and has pointed the way for a far more satisfactory comparative study of their physiology. For a full account of these investigations the reader is referred to the chapters dealing with this subject in the monographs of Vincent (33) and Biedl (4) and also to the chapters by Poll (28) in Hertwig's *Handbuch*. Space can only be found here for a brief summary.

*Comparative anatomy* and comparative physiology reveal the fact that the medulla of the adrenal body is not the only representative in the animal economy of the tissue (the chromaphil tissue) which forms it: there are numerous scattered bodies of the same nature in close relation to the sympathetic ganglia and nerves in different regions. In lower vertebrate animals the medulla (chromaphil bodies) and the cortex (interrenal bodies) form two separate and independent systems having no anatomical (and, so far as we know no physiological) relationship to each other (Fig. 1). Indeed strictly speaking the medullary substance is not part of the adrenal body at all, but simply an accumulation of the chromaphil tissue which has arisen from the sympathetic in certain abdominal segments, and has insinuated itself into the adrenal body proper or what is usually called the cortex. So that, using the correct morphological phraseology we ought

to refer to the adrenal body and its chromaphil nucleus or medulla, or according to Koha its paraganglion suprarenale.

Even the adrenal cortex is not a separate and independent organ for accessory adrenals are so common in many animals as to compel us to regard the adrenal cortex as part of a system in the same way as the medulla is part of a system (Fig. 2).

All this as will be seen, notwithstanding the numerous facts which have been accumulated renders the adrenal problem much more complex than it appeared to the earlier investigators.

In discussing the functional activities of the adrenal bodies these facts of comparative anatomy must not be overlooked. The question which yet remains to be solved is, not what is the function of the adrenal body but what are the functions respectively of the interrenal system (cortical system) and the chromaphil system (medullary system) which are separate and distinct in certain lower vertebrates, as for example, in elasmobranch fishes (see Fig. 1). There seems no reason to suspect that the functions of these two systems are in any way related to each other notwithstanding the fact that, as we approach the higher vertebrate animals certain portions of the two come into intimate connection with each other in order to form what we call the adrenal body.

For the present, and perhaps for some time to come, it will be wise on the part of investigators to search for a separate function for each of the two systems.

*Extracts of the medulla.* The view adopted by the majority of modern writers in regard to the medulla (and the chromaphil tissues generally) is that it secretes a sympathomimetic hormone whose function comes into play especially in conditions of emotional disturbance.

The great majority of investigations and by far the greater number of hypotheses regarding the function of the adrenal bodies

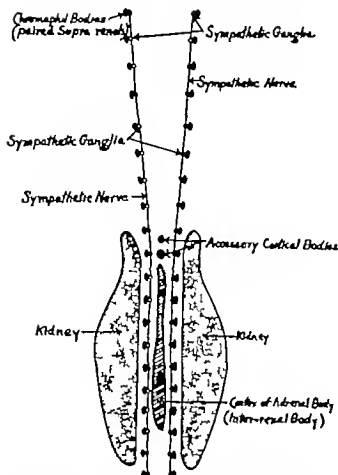


Fig. 1 Diagram of the adrenal representatives in elasmobranch fishes showing the cortical gland (intern-renal body) and the medullary glands (chromaphil bodies, "paired suprarenals") in relation to the sympathetic and the kidneys.

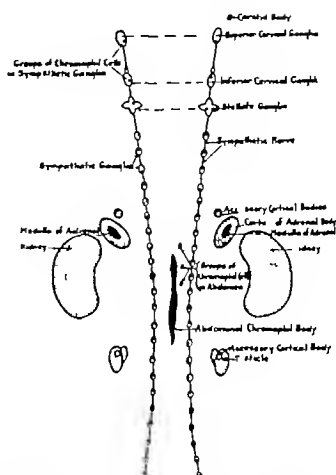


Fig. 2 Diagram of the adrenal constituents and out-standing cortical and medullary (chromaphil) bodies in the mammal showing the adrenal bodies, the chromaphil cells of the sympathetic, the abdominal chromaphil body (accessory medullary) and accessory cortical adrenals in relation to the sympathetic and the kidneys.

have been concerned with the secretion of the chromaphil tissue, and at the present time are centered on the physiological activities of adrenin. The cortical system as such has received comparatively little attention and even plausible hypotheses concerning it are very few. The tendency of many writers has been to assume that the adrenal problem is wrapped up in the pharmacodynamical action of adrenin. But this attitude leaves out of account the significance of what we must on morphological grounds regard as the true adrenal body that is to say the cortex.

There is now abundant experimental evidence that it is the cortex and not the medulla of the gland which is essential to life. When the whole gland is removed the animal usually dies within a few days while if the medulla

only be extirpated survival is in the majority of cases indefinite.

*Extracts of the cortex* The cortex of the adrenal body does not yield any very special physiological principle to extraction. It is true that extracts made from the cortex, when injected into the veins of a living animal will cause a lowering of the blood pressure but this action is common to extracts made from all organs and tissues (Osborne and Vincent, 24 and 25 Vincent and Sheen 35 and 36 Vincent and Cramer 37 and 38 and Webster 39). The substance which produces this effect has been shown not to be choline. It is possible that it may be beta iminazolyethylamine (Barger and Dale 3).

The cortex also contains certain substances called lipoids. The cortical cells contain numerous lipoid granules the so-called



cortical granules. Space will not permit a description of the chemical characters of lipoids. For this the reader is referred to the works of Vincent (33) and Biedl (4). It is not yet determined whether these lipid granules are to be regarded as secretion products which are about to be poured into the blood stream. Pigment granules and other cell-inclusions are also noted in certain cells of the cortex.

## II. CLINICAL EVIDENCE

There are four views as to the function of the adrenal cortex

1. That it is related to growth and development, especially of the sexual organs.
2. That it has an antitoxic function.
3. That it plays some part in the elaboration of the adrenin which is found in the medulla.
4. That the enormous development of the adrenal cortex in the human embryo is connected with the highly developed brain of man.

It is only with the first of these theories that we are here concerned. It is now tolerably certain that there is an intimate connection between sex characters and the adrenal cortex. Most of the evidence on this point is of a clinical nature.

Woolley (40, 41) and Bullock and Sequira (6) reported that tumors or hypertrophies of the adrenal body are sometimes associated with precocious development of the reproductive organs.

Glynn (10) has given an excellent account of the tumors and rests of the adrenal cortex with their relationships to sex abnormalities. The following is a brief abstract of his classification.

*A Benign tumors Cortical Group 1*  
Diffuse hyperplasia passing into

*Group 2 Adenomata* which may be bilateral. The cells contain a considerable amount of fat and their arrangement is like that of the zona fasciculata.

*B Malignant tumors Cortical Group 1*  
Sarcomata round-celled often lymphosarcoma i.e. small cells with an alveolar arrangement. These are common in children especially males between the ages of two and three.

*Group 2 Hypernephroma or mesothelioma,*

a tumor having large polyhedral epithelial cells, recalling the structure of the adrenal cortex.

*Hyperplasia* of the adrenal gland or of accessory adrenals is frequently associated with pseudohermaphroditism. The great majority of these cases occur in female pseudohermaphrodites that is to say in females with internal organs of the male type, illustrating the tendency of neoplasia or hyperplasia of the gland to be associated with the appearance of male characters in the female. In most of the females the hermaphroditism was advanced, for prostates were present. Glynn quotes thirteen cases in illustration of this condition.

*Adrenal hypernephromata* are almost invariably characterized in children by precocious growth of the body generally and of the sexual organs in particular with overgrowth of hair and fat. The skin becomes pigmented and the children are below the average in intellect. According to Guthrie (15) there are two types (1) the obese type, met with in both sexes but apart from the development of pubic hair the development of the sex organs is not exaggerated, though one of the females menstruated (2) the muscular or infant Hercules type, occurring only in males, who may show true sexual precocity.

*Hypernephromata of the adrenal body* in children are much commoner in females than in males and tend to increase the male primary and secondary sexual characters at the expense of the female.

Glynn quotes six examples of the tumor referred to in the last two paragraphs. These examples were found in young adult females and the growth was associated with changes in sex characters. It will be interesting to quote one of these [originally reported independently by Thummin (32) and Borts (5)].

A girl aged 6½ years began to menstruate at 5 and continued to regularly for one year. With the cessation she grew a beard and moustache, and hair developed also on the thorax and linea alba. The voice changed to the male type. She became very obese the mammae were well developed. She died of phlegmon of the hand. The external genitalia were of the feminine type the uterus measured 8 centimeters externally and was normal, but the

ovaries were small and hard showing no trace of ovulation neither macroscopically nor microscopically. The right adrenal contained two yellow nodular tumors the size of a cherry and the left was converted into a mass as big as a fist. Microscopically the right tumor consisted of round or polygonal epithelial cells in a network of capillaries those in the left showed similar structure, but the meshes were wider and more irregular. A few larger cells rich in chromatin and often multinucleated, were also present. The condition is described as typical of struma suprarenalis.

Gallaix (9) has recently observed and collected a number of cases in which tumors have given rise to striking abnormalities in the development of the reproductive organs. He groups them together under the title genito-adrenal syndrome. One form of this syndrome is characterized by sexual precocity other forms being such as are described above. He regards the cortex of the adrenal body as essentially a puberty gland.

The subject has also been discussed by Korányi (19)

### III EVIDENCES FROM COMPARATIVE ANATOMY AND PHYSIOLOGY

There are other evidences of the association between the adrenal cortex and the sexual functions.

*Functional variations* Stilling (31) in his researches upon the adrenal body of the rabbit observed periodic variations in the weight of these organs. There was enlargement of the glands in male rabbits during the breeding season. In the same communication he reports that the peripheral part of the cortex in the frog contains during the summer certain peculiar elements the summer cells which atrophy later on during the pairing season. Patzelt and Kubik (26) have however come to the conclusion that Stilling's summer cells are present the whole year round and are independent of age sex or state of nutrition. These authors prefer to call the cells in question acidophile cells from their staining reactions. A curious point is insisted upon by these writers. They find that the acidophile cells are only present in one species viz in *R. esculenta*. They are entirely wanting in the adrenal bodies of the other anura which they investigated as also

from the glands of the urodela and the reptalia. They note also that similar cells are found in the parathyroids of mammals and in the pituitary gland throughout vertebrates.

As far back as the year 1806 Meckel (20) noted a relationship between the adrenal bodies and the reproductive organs.

Nagel (23) in 1836 remarked that animals with large sexual organs and well developed reproductive instincts possessed large adrenal bodies which in birds and amphibians became still larger during the breeding season. According to Glynn these statements have been repeated quite recently by Aichel (1). Glynn remarks that it is highly probable that a similar change occurs in human beings but that there are no recorded observations on this point. He suggests that such an enlargement if it does take place may explain the curious tendency of any hair or down upon the face or body of a woman to increase in amount during pregnancy first noted by Hegar and confirmed by Halban (16). In the opinion of Glynn Halban wrongly explains this hypertrophosis gravidatus by a protective action of the placenta.

A hypertrophy of the adrenal bodies during pregnancy was noted by Gueysse in the guinea pig which enlargement chiefly affected the zona fasciculata. According to Schenk (30) quoted by Glynn these results have been confirmed by Ciaccio and Da Costa. Gottschau (12) found that the adrenal gland as a whole measured less in pregnant than in non pregnant animals but that the outer zone of the cortex was increased at the expense of the inner.

*Effect of castration* Feodosiew (8) removed the ovaries from bitches and found that after a few weeks there was hypertrophy of the adrenal cortex, especially the zona glomerulosa. Similar results were obtained by Rainen (29) but they could not be confirmed by Dick and Curtis (7) nor by de Mura (21).

*Resemblance between cortical adrenal cells and corpus luteum cells* It has long been noticed that there is a resemblance between the cells of the adrenal cortex and the interstitial elements of the ovary and testis and those of the corpus luteum. Janosik (18)

looked upon all these cells as being very closely related. Podvissotzky (27) insisted specially on the resemblance between the cells of the adrenal cortex and those of the corpus luteum. This was further emphasized by Mulon (22) who from observations on guineapigs goes so far as to speak of the corpus luteum of pregnancy as a temporary cortical adrenal body.

A further discussion of some of the above questions will be found in a recent work by Coffalons (11).

*Hormone hypothesis.* It seems hopeless at present to attempt any explanation of the precise manner or the essential mechanism of the influence of the adrenal cortex upon the reproductive organs. It is perhaps most in accordance with current views to admit the hypothesis that a certain hormone or certain hormones are secreted by the adrenal cortex which are passed into the blood stream and so reach and exert their action upon the reproductive organs. It has been suggested that the adrenal body may act through the mediation of the pituitary, but so far as I am aware no changes in the latter organ have been observed in any of the cases referred to above.

Much has been written and many hypotheses have been put forward on the subject of the relationships between the various organs furnishing an internal secretion. Much of this is purely hypothetical, and a great deal remains to be discovered before we can formulate any general statements.

It is possible that the simpler physiological conception of underaction or overaction respectively of the various ductless glands now used to account for the various pathological states may have to be supplemented or superseded by a consideration of modified or deranged function.

#### IV FEEDING EXPERIMENTS

During the present year an attempt has been made to investigate the relations between the adrenal bodies and the reproductive organs by studying the effects of feeding animals with the adrenal bodies or preparation made from them.

*Immediate effects.* Some years ago the present writer failed to observe any immediate physiological effect upon dogs, cats

and rabbits, after feeding with the adrenal bodies of sheep just as the administration of large doses of extracts (in some cases made from the medulla only) failed to produce any noticeable rise in the blood pressure in the human subject (Vincent, 34). D'Amato (3) has also shown that very large doses do not increase pressure although they may cause arterial degeneration. Gruenbaum (13) however states that adrenal extract although it ordinarily fails to produce elevation of blood pressure when administered by the mouth will bring about this effect in cases of Addison's disease.

*Effects of continued feeding.* But the experiments about to be described are of a different character. They involve the administration of comparatively small doses of gland substances over a long period in order to test the effect upon the growth of the body as a whole, and the reproductive organs in particular. R. G. and A. D. Hoskins (17) have carried out a series of experiments on white rats in which certain of the young animals were fed with desiccated adrenal gland while certain others were kept as controls. Forty-five rats were fed with adrenal body for varying periods of from two to nine weeks. Twenty-six animals from the same litters were kept as controls. The rate of growth and the weights of various glands were determined in each series. No differences between the two series could be detected in the case of the kidneys, heart, pituitary body, thyroid, thymus or adrenal bodies. The spleens of the experimental series were somewhat smaller than those of the controls, but highly variable in size. The ovaries in the few cases studied were larger in the experimental series. The testes (twenty-six experimental, thirteen control) showed hypertrophy. These results are in confirmation of the clinical evidence above stated and indicate that the adrenal bodies exercise a stimulating effect on the growth of the testes in young animals.

The authors of the communication just referred to discuss the question as to what constituent of the gland the testicular hypertrophy is due to. They conclude that it is in all probability to be ascribed to the cor-

tical portion. But it is obvious that the experiments would be more satisfactory as regards this point if the cortex only were employed for the feeding. A series of experiments of this type are now being carried out in my laboratory. A further criticism of the experiments above described seems justified from the fact that desiccated gland was used. I believe that the material is 'degreased' before it is 'desiccated,' and the former process would be likely to remove many lipoids, some of which might be among the physiologically active substances. In our experiments therefore we are using fresh cortex only in order to eliminate these sources of error. We are further extending the investigation to chicks, as was suggested by Hoskins.

## SUMMARY

1. What we call the adrenal body represents the anatomical association of two elements of which is derived from a separate and independent system. The adrenal proper or cortex is part of the cortical or interrenal system. The medulla is simply an accumulation of chromophil cells of the same nature histologically, chemically and pharmacodynamically as similar masses of cells in other parts of the body.

2. There is no clear evidence that these two systems are functionally related.

3. The adrenal medulla (as well as the chromophil tissue generally) is developed from the sympathetic nervous system. Its duty seems to be to facilitate the functions of this system in certain physiological emergencies.

4. The adrenal cortex (as well as the accessory cortical adrenals) is developed from the germ epithelium, and the evidence is now strongly in favor of the view that it has certain important functions in connection with the development and growth of the sex organs.

5. There is a considerable amount of clinical evidence that tumors of the adrenal cortex are frequently associated with sex abnormalities.

6. The clinical evidence also favors the view that when cortical tumors occur in the female, an accentuation of male secondary sexual characteristics develops and simul-

taneously a hypoplastic condition of the internal generative organs supervenes.

7. Additional evidences as to a connection between adrenal cortex and the sexual organs is furnished by the enlargement of the cortex during breeding and pregnancy.

8. Feeding young animals with adrenal gland substance seems to stimulate the growth of the testes.

9. It is possible that a final solution of the problem will only be arrived at when the more general problem of the relationships between the ductless glands shall have been solved.

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## THE RELATION OF THE OVARY TO THE UTERUS AND MAMMARY GLAND FROM THE EXPERIMENTAL ASPECT

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WE shall consider (1) the effects exerted on the uterus and the mammary gland by the ovary as a whole and (2) we shall further seek as far as possible to refer to individual structures within the ovary the various functions exercised by this organ. Therefore it will be necessary first to describe and analyze certain cyclic processes within the ovary itself inasmuch as its function varies at different periods in accordance with its cyclic changes.

First, we shall discuss the various structures found in the ovary and then proceed to a description and an analysis of the mechanism governing cyclic changes in the ovary. Further we shall discuss the significance of the effect exerted by the ovaries upon the cyclic changes in the uterus and in the mammary gland and as a phase in these effects we shall especially consider the relation of ovary to uterus and mammary gland during pregnancy. This will be followed by a consideration of the influence of the ovaries on the full development of uterus and mammary gland during puberty and on the ultimate atrophy of these organs. Lastly we shall refer to the influence of the ovaries on the development of cancer of the mammary gland. In this brief report it will hardly be possible to do much more than summarize the principal results obtained in experimental research.

### I. CONSTITUENTS OF THE OVARY

The follicle with the ovum is the most important constituent of the ovary. Secondly it gives origin to two new structures, the corpus luteum and the so-called interstitial gland. After the rupture of the mature follicle the granulosa becomes transformed into the cells of the corpus luteum. We cannot wholly exclude the possibility that some enlarged theca interna cells form the periphery of the corpus luteum. In some species the

corpus luteum cells multiply mitotically; in others the large size of the corpus luteum is merely due to an increase in size of the granulosa cells (1).

Follicular atresia occurs in a large number of the follicles. Only a small number of the follicles mature and give rise to corpora lutea. The majority degenerate become atretic before maturity but usually only after they have reached a considerable size. Thus degeneration of the follicles usually begins in certain species at a time when the ova are still alive and active and this atresia is therefore not, as has been maintained by Robert Meyer (2) the result of a primary degeneration of the ovum. During this process of atresia the theca interna cells enlarge in some species of animals, become epithelioid gland-like in appearance and remain preserved in such a state for a considerable period of time such is the case in the rabbit (3). In other species however the theca interna cells remain small and have only a relatively short existence after the atresia of the follicles has set in. This latter condition we find for instance in the guinea pig (4) and in woman in the absence of pregnancy (5).

In the guinea pig where the theca interna cells of atretic follicles are not in the least gland like and have only a transitory existence it is not permissible to speak of the existence of an interstitial gland. There is a certain lack of clearness in the definition of the interstitial gland of the ovary certain authors considering the presence of fat like substances in atretic follicles as a sufficient characteristic. Such substances, however are found in the granulosa and theca interna cells of non-degenerating as well as in theca interna cells of atretic follicles. Intracellular fat globules appear also under certain conditions, in many varieties of other cells therefore we usually do not consider such cells as gland cells. The size and shape of the cells and their intimate relationship to capillaries are

the features most characteristic of the so-called interstitial gland of the ovary

It has been suggested by Ancel and Boulou (6) that in those animals in which periodic corpora lutea form no interstitial gland exists that it is present only in those animals in which a spontaneous ovulation does not take place. Boulou and Ancel cite the rabbit as well as the guinea pig as animals possessing an interstitial gland. However there is no doubt that in the guinea pig a spontaneous ovulation takes place at regular periods while in the rabbit it usually does not take place if copulation is prevented. This seems contradictory to the suggestion made by these authors if we accept their statement that the guinea pig possesses an interstitial gland. If on the other hand, we define the term "interstitial gland" as suggested above, then the rabbit but not the guinea pig possesses an interstitial gland. The hypothesis of these two authors might therefore still hold good. It is readily conceivable considering the large space required by the periodic corpora lutea, that such relationship between the presence of interstitial gland and the absence of spontaneous ovulation should exist considering furthermore the fact that at the time of ovulation all of the medium sized and large follicles degenerate at least in certain of the species with spontaneous ovulation. Thus at short intervals of time a large aggregation of new atretic follicles is created, which in turn necessitates the disappearance of an equal number of somewhat older atretic follicles. Under those conditions it is clear that the regular recurrence of spontaneous ovulation and the existence of a typical interstitial gland must necessarily be mutually exclusive. While some considerations thus make plausible the hypothesis of Boulou and Ancel, this relationship requires further investigation.

There exists another element in a certain number of ovaries which deserves special mention. In a considerable number of guinea pigs we discovered a relatively fargoring development of the ovum which leads to the formation of the embryonal placenta and in some cases to the development of early stages of the embryo proper (formation of the anlage of the central nervous system) within the follicle (7). Ultimately these structures perish but it is important to know that parthenogenetically developing embryonal structures occur in certain ovaries if we wish to trace to their source the various functions exercised by the ovaries. In addition we find medullary canals or cell rows which are of extraneous origin and unite only secondarily with the ovary. As far as we know no definite function can be attributed to them.

## II CYCLICAL CHANGES OCCURRING IN THE OVARIES

In the ovaries of some species well-defined cyclic changes occur (8). They are not equally present in all species. In the guinea pig just prior to ovulation a simultaneous sudden degeneration of all but the smallest follicles sets in while in other species the cyclic ovulation seems merely to lead to the formation of periodic corpora lutea without a concomitant revolutionary change in the condition of the follicles. In still others as in the rabbit, such regular cyclic changes are dependent on the occurrence of copulation and subsequent pregnancy. After completion of pregnancy the animal is accessible to a new copulation and a new pregnancy occurs. In this latter class of animals spontaneous ovulation without a preceding copulation does not usually take place. Again in other species copulation and pregnancy are limited to certain seasons.

The initiation of the cyclic changes in the ovary as well as the development of the corpus luteum depend on ovulation. Ovulation is probably preceded by marked changes of the circulatory conditions in the ovary which lead to atresia of follicles. In one case however we apparently succeeded in producing corpora lutea experimentally without the occurrence of a spontaneous ovulation and the concomitant degeneration of follicles by cutting into a mature follicle in the guinea pig (9). In the rabbit, such an experimental production of corpora lutea can be more readily accomplished according to the findings of Ancel and Boulou (10) and of Regaud and Dubreuil (11).

We must analyze the conditions that lead to ovulation if we wish to obtain an understanding of the cyclic changes in the ovary and of the consecutive cyclic changes in the uterus and mammary gland. We are now in a position to give an analysis of this process which while not yet complete in every particular at least defines its principal factors.

Ovulation is retarded by the corpus luteum and the essential factor in this process is the existence within the ovary of a self-regulating mechanism. The corpus luteum

itself the result of an ovulation provides a mechanism preventing ovulation and therefore the production of new corpora lutea. The mechanism is automatic comparable to that regulating respiration.

Several writers such as Beard (12) Prentiss (13) Sandes (14) and Skrobanski (15) have expressed hypothetically the view that the corpus luteum might prevent ovulation. None of them attempted to give a proof of this suggestion and the majority of all investigators rejected it. Experiments on a large scale which the writer carried out without the knowledge of the writings of the previous authors however proved without doubt that the corpus luteum actually possesses such an influence (16).

Ovulation is accelerated by the removal of corpus luteum for we find that if at an early period of the sexual cycle we cut out all the corpora lutea the next ovulation is much accelerated and the sexual period shortened. These experimental findings were recently confirmed by Raymond Pearl and Surface (17). They showed that injections of corpus luteum extract into fowl delayed or prevented ovulation the number of eggs laid was considerably diminished in the injected animals. We carried out a few similar experiments on guinea pigs. While in some injected guinea pigs ovulation was apparently delayed in others it took place at the expected term despite the fact that these animals had repeatedly received large doses of lutein (18). We may therefore conclude that injections of lutein extract cannot wholly take the place of the living corpus luteum. Whether or not they can do so partially in mammals, I am not prepared to say on the evidence at hand.

The acceleration of ovulation produced through extirpation of the corpora lutea is limited the next ovulation has to await the maturation of follicles. Without the presence of mature follicles a new ovulation cannot take place even in the absence of corpora lutea.

There is a third set of accessory factors of significance in the occurrence of ovulation chief among which is copulation. The importance of this factor varies considerably in different species of animals. In the guinea

pig it has at best only a slight significance on the other hand, it is very important in the rabbit where usually despite the presence of the first two factors ovulation does not take place without a preceding copulation (19).

Ovulation is retarded by the presence of deciduomata. There is no doubt that the presence of an experimentally produced deciduoma in the uterus (or its equivalent during pregnancy the maternal placenta—*vide infra*) as long as it is growing or at least living, has a certain delaying effect on ovulation (20). This effect, however is only present provided the corpora lutea have not previously been extirpated. If this has been done the premature ovulation occurs, even in the presence of a well developed deciduoma (21) and as we shall shortly see of a maternal placenta.

We must therefore assume that the deciduoma either acts by prolonging the functioning of the corpus luteum and thus indirectly preventing copulation or that we have to deal with the summation of the effect of corpora lutea and deciduoma under conditions in which either alone would be too weak to prevent ovulation.

But this delay is only temporary sooner or later the ovulation takes place notwithstanding the presence of a deciduoma. Whether or not in such cases ovulation has to be preceded by the death of the greater part of the deciduoma is at present still an open question. It seems, however that extirpation of the whole or of the greater part of the uterus even without the presence of deciduoma, may lead to a prolongation of the life of the corpus luteum and a delay in ovulation (18). Here also further investigations are necessary. Extirpation of the greater part of the thyroid on the other hand, need not be followed by a delay in ovulation in the guinea pig (20).

Prolonged retardation of ovulation occurs as the result of the presence of a corpus luteum of pregnancy. During pregnancy the corpus luteum persists—at least in the guinea pig—and therefore no ovulation takes place during pregnancy. There is at present no species of animals known where ovulation occurs during pregnancy. If we extirpate the corpora lutea of a pregnant guinea pig however at the time when such an interference does

not necessarily lead to an interruption of pregnancy a new ovulation occurs in the pregnant animal just as early as in a non-pregnant animal under the same conditions. Such an ovulation during pregnancy may take place without leading to abortion. It is therefore essentially the function of the corpus luteum which prevents a new ovulation during pregnancy and not the direct action of the embryo. It is possible that in certain species secondary factors active during pregnancy are added to the influence of the corpus luteum. This we would have to assume if in some species the corpora lutea should be found entirely absent during the second part of pregnancy.

It would be of great interest to discover the factor responsible for the prolonged life of the corpus luteum during pregnancy. We suggested formerly the possibility that the embryo has such a function, however a more recent observation makes the correctness of this hypothesis doubtful. In an early stage of an extra-uterine pregnancy experimentally produced we observed degeneration of the corpora lutea and subsequent new ovulation notwithstanding the presence of a living embryo of autochthonous origin (21). Furthermore interesting experiments of R. T. Frank, who found that implantation of fetal structures into rats, which led to the production of teratomata, did not prevent degeneration of corpora lutea, point to the same conclusion (22). It is therefore in all probability not the direct influence of the embryo which prolongs the life of the corpora lutea and prevents ovulation during pregnancy. We stated above that in cases in which growing deciduomata were present in the uterus, ovulation was delayed and apparently the life of the corpora lutea prolonged. Thus it is possible that the maternal placenta plays an active rôle in preserving the life of the corpora lutea. Whether this effect is direct or indirect, perhaps by influencing of circulatory conditions in uterus and ovaries, is as yet uncertain. We may consider it as very probable that the same factors which prolong the life of the corpus luteum during pregnancy are also responsible for the greater development of the theca interna (23) and for the development of decidua like cells in the cortex of the ovary and occasionally elsewhere in adjoining organs in woman.

After we had established the significance of the corpus luteum for ovulation two questions had still to be decided. (1) Is the effect of the corpus luteum in preventing ovulation a merely mechanical one or is it due to more complex action? (2) Does the corpus luteum prevent ovulation by interfering with the

maturation of follicles or by preventing the rupture of the follicle?

As to the first question we could show that the effect of the corpus luteum is not a mechanical one. Extirpation of other parts of the ovary are without effect. Extirpation of the corpus luteum in one ovary affects ovulation in the other ovary. Inasmuch as the presence of sensory nerves in rapidly developing corpora lutea at early stages of development is improbable we have to assume that the action of the corpus luteum is a chemical one. A substance secreted by the corpus luteum affects the follicles either directly or indirectly through influence upon the vasomotor nerves in the ovary.

As to the second question we can state that in the guinea pig and rabbit, the corpus luteum merely prevents ovulation, and not the maturation of follicles which takes place in a normal manner (24). Possibly the same factor which prevents ovulation may in other species as for instance in man have the additional power of preventing the full development of the follicles. At least it seems that in man and certain other species a full development of follicles does not take place during pregnancy (23). If the finding of Stratz who states that in *Tupaia* and some related animals well-developed corpora lutea are absent during the latter part of pregnancy is correct then we would have to assume that some other factor than the corpus luteum prevents the full development of follicles an interpretation which would harmonize well with the fact that in certain species follicles become mature during pregnancy (24).

In discussing the action of interstitial gland we mentioned above that Ancel and Boun (6) assume that the occurrence of periodic corpora lutea and of interstitial gland are mutually exclusive this would imply that animals with an interstitial gland do not ovulate spontaneously. We found that in animals with periodic corpora lutea (guinea pig) the presence of corpora lutea leads to an inhibition of ovulation. Now if it should prove correct that animals possessing an interstitial gland do not ovulate spontaneously we may suggest that possibly the so-called interstitial gland is the structure responsible for this in



hibition, that it increases the tonus of those mechanisms which oppose ovulation therefore additional factors as copulation must come into play in order to overcome the greater strength of the inhibitive factors. At present we can regard such a statement merely as a hypothesis which may however deserve consideration.

### III. RELATION OF OVARIAN TO UTERINE CYCLE

After this analysis of the self regulating mechanisms within the ovary and especially of the rôle of the corpus luteum in this mechanism and of the factors underlying ovulation we shall next consider the relation between ovarian and uterine cycles.

The anatomist Born expressed hypothetically the view that it is the function of the corpus luteum to make possible the nidation of the ovum in the uterine mucosa and to insure the development of the embryo. L. Fraenkel (25) put Born's hypothesis to an experimental test on rabbits that had copulated by inquiring into the effects of castration and of burning out of the corpora lutea on the course of pregnancy. He came to the conclusion that castration as well as burning of the corpora lutea in the first half of pregnancy led to retrogression of pregnancy and to abortion. The number of the experiments on which he based his conclusion was however relatively small furthermore pregnancy is readily influenced by other operative and experimental procedures and therefore in the years following Fraenkel's publication, his conclusions, as far as they concerned the effect of the corpora lutea on pregnancy were not accepted by many perhaps not by the majority of gynecologists, while the effect of ovariectomy was conceded if not by all at least by the larger number of investigators. It was only several years after the significance of the corpus luteum for the uterine cycle and for the development of the maternal placenta had been established by safer methods (26) that Fraenkel (27) in another publication published the results of a larger number of experiments which showed that after removal of the corpora lutea pregnancy is interrupted in a much greater number of cases than after other experimental interferences.

But even granted that the extirpation of corpora lutea during the first half of pregnancy interferes with the progress of pregnancy such a conclusion would not give us any insight into the manner in which the corpus luteum affects the uterine mucosa. On this basis any explanation would be purely hypothetical. As a matter of fact Fraenkel did not express clearly his views as to the manner in which the corpus luteum acted on the uterine mucosa. He speaks of a softening trophic, hyperæmic influence of the corpus luteum on the mucosa which makes it suitable for the nidation and development of the ovum. He disclaims the belief that the corpus luteum has necessarily anything to do with the development of the maternal placenta (25).

The experimental method used by Fraenkel was not suited to throw light on the influence exerted by the corpus luteum on the uterus. This influence could be elucidated only in experiments in which the changes in the uterus could be studied directly without the interference of a fertilized ovum. It was therefore necessary to exclude pregnancy. This was accomplished either by ligation of the fallopian tubes soon after copulation, or by using guinea pigs (females kept separated from males) in which heat had been observed (26). In the normal guinea pig a spontaneous ovulation takes place at the time of heat in almost all cases. The same principle was later applied by Bouin and Ancel in a somewhat modified form (28) these investigators prevented pregnancy and determined ovulation by copulating female rabbits with a male whose vasa deferentia had been previously ligatured. We succeeded furthermore in substituting ordinary foreign bodies and other mechanical stimuli for the action of the ovum and thus we were able to analyze the factors that regulate the cyclic changes in the uterus and the development of the maternal placenta.

We shall present in the following paragraphs some of the principal conclusions (26) derived from these investigations. If we apply certain well-defined mechanical stimuli to a uterine mucosa which has been previously sensitized by the internal secretion of the corpus luteum, a maternal placenta is pro-

duced at the place of stimulation. The mechanical stimulus takes the place of the ovum. Without the presence of a mechanical stimulus the uterine mucosa undergoes slight decidual changes under the influence of a substance secreted by the corpus luteum. We may assume that in the latter case the stimuli present in normal life and acting on a sensitized uterus produce these proliferative changes.

After the foregoing facts had been established by the writer Ancel and Bouin (28) in the case of the rabbit, and ourselves (20) in the case of the guinea pig, studied in detail the parallelism between the development of the corpus luteum and the cyclic changes in the uterine mucosa. The experimental production of the maternal placenta has been accomplished by ourselves and subsequently by Bouin and Ancel, Biedl and others, in the case of the rabbit and guinea pig, and by R. T. Frank (21) in the case of the rat.

It is possible to produce experimentally a much larger quantity of maternal placenta than is ever produced in life. In this as in other cases there is present a margin of reserve force which is not called upon in the actual conditions of life.

Variations in response to the sensitizing substance were noted. Certain relations exist between the quantity of the chemical substance given off by the corpus luteum and the response obtained by a mechanical stimulus. The mechanical (in the case of the maternal placenta) or the metabolic stimulus (in the case of the ordinary cyclic decidual changes) elicits a response in the form of growth processes of the uterine mucosa only after the latter has received a certain quantity of this substance and has thus been sensitized. If the mechanical stimulus is applied at the time at which the corpus luteum is beginning to secrete no growth reaction or only a trace, is obtained. On the other hand after the substance has fully sensitized the uterine wall the secretion of the substance continues for a few more days and increases the growth reaction which has now reached its maximum development. By experiments in which the uterus is transplanted at various periods of sensitization the curve of sensitization can be

established and furthermore it can be proved that the secretion of the substance continues for some time after the mechanical stimulus has been applied if the optimum time has been selected. The egg fixes itself in the uterine mucosa at approximately the time when the maximum sensitization of the mucosa has been obtained.

The sensitizing substance is not individual—specific the substance of one individual is able to call forth growth processes in the sensitized uterus of a different individual of the same species. But certain other substances (homotoxins) in the second individual cause the reaction in the strange organism to be less marked than in the organism to which it belonged.

The sensitizing substance produces in each species specific growth reactions which differ from those produced in other species. The structure of the experimental deciduomata in a given species corresponds to the normal structure of the maternal placenta during pregnancy. It is probably this unlikeness in the structure of the placenta in various species (dependent upon quantitative differences in the cell proliferation of various tissues and on differences in the period at which this cell proliferation sets in) that accounts for the apparent dissimilarity in readiness of response to stimuli producing artificial deciduomata.

In the guinea pig and probably in the rabbit the sensitization through corpus luteum substance is strictly limited to the mucosa of the uterus. In the guinea pig deciduomata or decidual reaction can be experimentally produced only in the uterine mucosa. With this fact accords the observation that in cases of extra uterine pregnancy in guinea pigs which were found by the writer (7) occurring in the ovaries as the result of parthenogenetic development of the egg and in a case experimentally produced on the peritoneal side of the uterus (21) only the embryonal placenta is produced without any reaction on the part of the surrounding maternal tissue. But while the egg can fix itself without decidua, the development of the embryo under these conditions is very much retarded and remains incomplete and apparently the later

stages of embryonal development are not reached

It is different in women and perhaps in certain other mammals. Here we normally find during pregnancy that in the cortex of the ovary and in adjoining organs elsewhere there is a transformation of stroma cells into cells which at least resemble decidua cells. It seems furthermore that in these species decidua can be produced in the fallopian tubes in cases of tubal pregnancy. In the guinea pig it has so far been impossible for the writer to produce tubal pregnancy experimentally and as previously stated in those cases in which extra uterine pregnancy was produced or observed elsewhere than in the tube a much delayed development occurred apparently not leading to the formation of a mature fetus. May not the explanation be that the difference in the readiness with which extra uterine pregnancy develops in different species depends in part at least upon the readiness with which the stroma of the host responds with the production of a decidua favorable for the development of the embryo?

Deciduomata produced experimentally have a limited existence varying in different cases. They usually become necrotic after a life extending over a period varying approximately between 12 and 20 days. The cyclic proliferation in the uterine mucosa has a duration of only a few days. Extirpation of the ovaries or of the corpora lutea at a time when enough sensitizing substance has reached the uterine mucosa to cause production of deciduomata in the majority of cases not only prevents the deciduomata from attaining their full size but causes an earlier and more extensive degeneration of such deciduomata as develop under these conditions. The necroses observed in these cases are usually combined with hemorrhages and it appears that the hemorrhages are the cause of at least a considerable part of the necroses.

On the other hand deciduomata produced by mechanical means in one horn of the uterus, while the other horn is pregnant, show a great prolongation of life at times through the whole period of pregnancy this prolongation

of life of the deciduoma accords with the fact that during pregnancy the decidua remains alive unless the chorionic cells of the embryo destroy it. But the behavior of the deciduomata in a non pregnant horn of the uterus proves that this prolongation of life is not due to the direct localized effect of the embryo or chorion but to a distant effect of either the embryonic structures or of the corpora lutea which persist during pregnancy.

Which one of these alternatives is the true cause of the prolongation of life of the deciduomata during pregnancy we cannot definitely decide. We may however state that if the corpus luteum should prove to be the cause of the longer life of the decidua, this effect cannot be due to a continuous elaboration by the corpus luteum of the substance which calls forth the growth of the decidua or of the deciduoma for we can show that at a time when the life of the deciduoma is thus prolonged the sensitizing substance is no longer produced in the corpus luteum, or is produced in such small quantities that it is no longer able to effect a sensitization to mechanical growth stimuli. In fact the production of this sensitizing substance extends only over a relatively short period in the early life of the corpus luteum.

We must then assume either that we have to deal with two entirely different actions of the corpus luteum the one responsible for the sensitization of the uterus and the other for the prolongation of life of the deciduoma or that only one substance is secreted but in different quantities at different periods of the life of the corpus luteum. A sensitization leading to the new formation of decidua would require a much greater quantity of substance than preservation of decidua already produced.

It is a well known fact that, in cases of tubal pregnancy in woman, decidual changes can be found in the uterus. In this case we evidently have to deal with a similar condition. The decidual growth in the uterus initiated through the developing corpus luteum in a manner corresponding to the one found normally at a definite period of the sexual cycle in the guinea pig and rabbit (but possibly somewhat more vigorous under the in

fluence of the corpus luteum of pregnancy) is protected from the degenerative processes which would affect it without pregnancy, just as the deciduoma is kept alive through distention action during pregnancy

#### IV CYCLICAL CHANGES IN THE UTERUS

Corresponding to the cyclic changes in the ovary a definite cycle of changes occurs in the uterus (20 and 28). This cycle includes alternating periods of activity and rest and manifests itself in changes in epithelial as well as in connective tissue structures. It is impossible at this place to attempt a description of these changes but casual mention may be made that in the guinea pig solely on the basis of these uterine changes it is possible to determine whether an ovulation is impending or whether it has just been completed without recourse to an examination of the ovaries (20). As far as the mechanism of these changes is concerned we can divide the cycle into two or more periods. The first period comprising the heat changes in the uterus and the changes accompanying and directly following ovulation is not caused by the activity of the corpus luteum but on the contrary is actually prevented by it. Preceding extirpation or degeneration of the corpora lutea is a prerequisite for this phase of the uterine cycle. It does not, however occur in the absence of the ovary (26, 20 and 16). The question therefore arises as to which part of the ovary is responsible for these changes in the uterus.

That the so-called interstitial gland causes heat and ovulation is improbable for the following reasons: (a) In the guinea pig and numerous other species an interstitial gland in the sense in which we use this term does not occur. (b) The analogon of an interstitial gland, the theca interna of atretic follicles is very strongly developed at periods in which heat is absent as for instance 5 to 7 days after ovulation and is present also in old guinea pigs or in animals with so-called hypotypical ovaries (24). (c) If we examine the ovaries of guinea pigs at the period immediately preceding their first ovulation we find only a relatively small number of atretic follicles and the so-called interstitial gland

or its analogon plays no significant part in such an ovary. There are, however one or more mature follicles invariably present at the time of heat. The character of the granulosa cells of mature follicles differs in certain respects from those of ordinary large follicles. It is therefore probable that, in the absence of the inhibiting substance secreted by the corpus luteum the mature follicles give off the substance causing the phenomena of growth and produce the circulatory changes characteristic of this period. We have some ground for the belief that directly or indirectly the same two factors (presence of mature follicles and absence of corpora lutea) are likewise responsible for the psychical manifestations of heat in those species in which sexual desire is limited to certain periods. On the whole the psychical signs of heat are more variable than the bodily manifestations and, with the gradual development of a thought world, substituting in the individual to some extent the real world these psychical phenomena become more or less independent of the factors to which they owe their origin. While it is thus very probable that the mature follicles are responsible for this phase of the sexual cycle we can at the present time not altogether exclude the participation of some other constituents of the follicular apparatus.

The second phase of the sexual cycle stands under the influence of the corpus luteum. The corpus luteum calls forth weak decidual growth processes in the non pregnant animal. In case pregnancy does not develop this phase is followed by a third phase in which the corpus luteum has ceased to secrete the growth substance and retrogression of the proliferative changes of the second phase takes place. If pregnancy does take place the proliferation proceeds to the formation of a decidua. In the fourth phase this substance is likewise absent and the uterus is resting. Even if pregnancy does occur the corpus luteum ceases to produce the growth substance at the same time as without pregnancy. In both cases this substance is present in the guinea pig only from the second or third to the eighth or ninth day after ovulation. The conclusion that in the third and fourth phases of the sexual cycle the growth substance of the

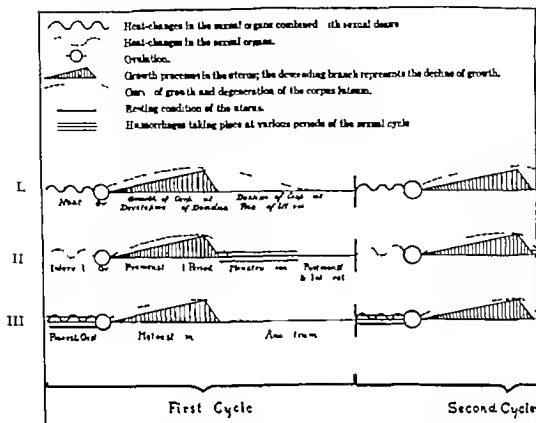
corpus luteum is no longer secreted is not merely an hypothesis based on histological inferences, but has been definitely proved by us through several series of experiments (26).

We note above that through the extirpation of corpora lutea a new ovulation and with it the onset of a new sexual cycle in the uterus can be accelerated. This experimentally accelerated heat and ovulation calls forth the same course of cyclic changes in the uterus which would be found in the case of ovulation at the normal time. There is however one exception to this rule: if in a pregnant animal all the corpora lutea are excised the onset of a new ovulation is hastened as was stated above but during pregnancy the accelerated ovulation is not followed by the onset of a new cycle in the uterine mucosa (20). Even places of the uterine mucosa distant from the insertion of the ovum do not undergo any of the cyclic changes noted in non-pregnant animals. During pregnancy there must therefore be present some (chemical—?) mechanism which neutralizes the effect of the substances which affect the growth phenomena in the uterus (mature follicles—?) and corpora lutea. There is therefore a double mechanism which protects the pregnant animal from a new ovulation and its effects, namely (a) the persistence of the corpus luteum which prevents a new ovulation during pregnancy and (b) if this barrier should be broken there remains a second as yet unanalyzed line of defense by which the uterus is prevented from reacting in the usual manner to the growth substances produced in the ovary.

Is action of corpus luteum on uterus and on ovary due to production of two substances? During the early period of its existence the corpus luteum, as stated, produces a growth substance which affects the uterus. After the first period has passed the existence of this substance cannot be demonstrated despite the fact that the uterus maintains its power to react to such a substance in the typical manner (26)—as shown by the effects of an artificially accelerated ovulation (16 and 20). On the other hand we have seen that the corpus luteum produces throughout a much longer period of its existence a substance which prevents ovulation (16). Shall

we then conclude that the corpus luteum produces two different substances one determining growth processes in the uterus and the other the inhibition of ovulation or are we dealing with differences in the quantity in which one and the same substance is produced at different periods of the life of the corpus luteum? In the latter case we would have to make the further assumption that for the growth effects a much larger quantity of this substance is required than for the inhibition of ovulation. This question cannot be definitely answered at the present time, but we must consider it a step forward that the established facts make it possible to put the problem in such a definite manner.

After the mechanism of the cyclic changes in the uterus had thus been experimentally analyzed in the case of non-menstruating animals, it was of interest to correlate with this cycle the cyclic changes found in the uterus of menstruating animals. The cyclic changes in the uterus of menstruating animals have been studied especially by Heape (29), Marshall (30) and Hirschmann and Adler (31). Subsequently Robert Meyer (2), Ruge (32), Schroeder (33) and others applied the knowledge which the experimental analysis of the sexual cycle in the guinea pig and rabbit had furnished especially as to the significance of the corpus luteum to the study of the sexual cycle in woman and correlated these cyclic changes with the periods of development and decline of the corpus luteum. A constant comparison between these cycles led necessarily to the conclusion that the growth processes in the uterus must be preceded by ovulation and thus the views of L. Fraenkel (25 and 27) who maintained that ovulation preceded menstruation were confirmed. We may then infer that conditions in woman are essentially the same as in the animals in which the mechanism of the sexual cycle had previously been established by experiment. Uterine heat and ovulation and the morphological changes accompanying them depend upon the absence of the corpus luteum, while the decidual changes and phenomena of secretion in the glands, depend upon its presence. Menstruation introduces a complication into the cycle inasmuch as



Diagrammatic representation of the sexual cycle. I. In the guinea pig II. In apes and women. III. In the dog.

the cessation of growth processes is followed by necrotic changes in the mucosa and by haemorrhages. These changes are perhaps in some respects analogous to those observed in deciduomata and in tumors here also a cessation of growth processes is followed by haemorrhage and necrosis of the tissues. In the uterine cycle of menstruating animals there is therefore added to the growth phenomena initiated by the corpus luteum and mature follicle a secondary growth process namely a regeneration of defects in the uterine mucosa.

It is highly probable that vasomotor phenomena play some part in menstruation. These vasomotor phenomena are normally dominated by the ovary and probably by the corpus luteum. Menstruation commonly ceases soon after castration and reappears after transplantation of the ovaries, as Halban (34) and others have shown. Observations have however been recorded (Gellhorn 35 and others) which seem to indicate that menstruation may persist for a long

period of time without the presence of ovaries. It is possible that in those cases which were complicated by inflammatory processes in the pelvis remnants of ovaries had remained inasmuch as the complete absence of the ovaries has as far as we are aware not been verified by autopsies. But if it is true that menstruation may actually occur permanently without the presence of ovaries and not merely for a brief period following castration we would have to assume that certain vasomotor phenomena after they have once been initiated by the ovaries may later be called forth through processes in the cerebral nervous system. The fact that hypnotic suggestion can influence the time of the onset of menstruation indicates that the central nervous system does play a certain rôle in menstruation.

There are certain animals in which the uterine cyclic changes are still wrongly interpreted by some recent workers. I refer particularly to the cycle in the dog. Here slight haemorrhages seem to occur during the

period of heat these hemorrhages have been erroneously analogized with menstruation in primates. The careful work of Keller (36) however makes it perfectly clear that these hemorrhages are due to the hyperemia which characterize the uterine mucosa at the time of heat and ovulation. True menstruation evidently does not occur in the dog. The cycle in the dog accords therefore in all essentials with what has been established experimentally in the guinea pig and in the rabbit and likewise confirmed in the case of woman. It is therefore inadmissible to use such cyclic changes as an argument against the significance of the corpus luteum for menstruation.

#### V. OTHER NON-CYCLICAL OVARIAN INFLUENCES

In addition to the functions which we have discussed so far and which refer to cyclical changes within the ovary and uterus the ovary exerts a trophic influence of a non cyclical nature. After extirpation of the ovaries the uterus becomes markedly atrophic. This effect however does not immediately follow castration. Considerable time must elapse before the atrophy becomes very marked. In a similar manner atrophy of the mammary gland follows castration. If the castration takes place before puberty neither uterus nor mammary gland become sexually mature. Likewise at the onset of the menopause atrophic conditions in the ovary are accompanied by atrophy of uterus and mammary gland. Through transplantation of the ovaries in animals and man, it has been possible to prevent the atrophy of the uterus and mammary gland which follows castration or lack of function of the ovaries. (Morris, 37 Knauer 38 Halban, 39 Marshall and Jolly 40 Martin, 41 and others)

The ovary determines the development of secondary sexual characters in the female and it is even possible through transplantation of the ovaries into castrated males to call forth growth processes in the mammary gland (Steinach, 42 Athias 43) and to change male into female psychical characters (42). As Steinach has shown the ovaries not only stimulate the development of female sexual characters but also inhibit the development

of male characters (42). On the basis of the effect of transplantation of the ovaries we may conclude that the ovaries exert this influence through a substance given off into the circulation. This substance then acts on the uterus and mammary glands and other organs either directly or through the nervous system. Which part of the ovaries exerts this function it is impossible to state at present with any degree of certainty. Steinach believes, it seems to me without sufficient foundation, that the interstitial gland is responsible for this effect. Pearl who describes in a cow the change from certain female into male characters, believes that the absence of a substance secreted by the corpus luteum was responsible for this change, because the cystic ovaries of the animal contained all ovarian constituents with exception of the corpus luteum (44).

In more recent experiments Pearl (45) succeeded in diminishing in female fowl the retardation in growth characteristic of the female sex by adding Ca salts to the diet. corpus luteum substance or extracts of corpus luteum in NaCl solution counteracted the effect of the Ca salts and thus tended to preserve the female differential characters. Pearl concludes therefore that the corpus luteum is responsible for the production of secondary sexual characters. And inasmuch as corpus luteum is not present in fowl, he furthermore concludes that an identical substance must be produced also in other parts of ovary. If this assumption should prove correct it then would follow that there are several active substances in the corpus luteum, because the substances through which the corpus luteum affects the cyclic changes in the uterus and which regulate ovulation, are not present in the rest of the ovary but only in the corpora lutea, and the substance responsible for the cyclic changes in the uterus appears only at certain periods in the life of the corpus luteum. At best we can therefore assume on the basis of Pearl's interesting experiments that certain substances present in the corpus luteum are not specific, but common to both the corpus luteum and the rest of the ovary. It would be very desirable to carry on control experiments in which ovarian instead of corpus luteum substance were used in similar experiments.

#### VI. EFFECTS PRODUCED BY OVARIAN EXTRACTS

Attempts have been made to throw additional light on the character of the active substances in the ovaries by injecting extracts or press juices of constituents of the ovaries or other organs into virgin or castrated

animals. We found that the repeated inoculation of the corpus luteum of the guinea pig at a time when it was known to contain the active growth substance into other guinea pigs did not have the effect of the living corpus luteum which is secreted continuously within the organism. It is however possible that it exerted a slight effect in one or two cases. R. T. Frank (47) found that injection of corpus luteum substance obtained from other species was without effect on the cyclic changes of the uterus and did not permit the production of deciduomata. In more recent experiments we found that injection of cow corpus luteum extracts in NaCl solution does not prevent necrosis of the deciduomata nor does it prolong the life of deciduomata in guinea pigs (18). On the other hand recent experiments by Aschner (48) Adler (49) Fellner (50) Schuckele (51) Okintschitz (52) seem to establish the fact that injection of extracts or press juices of ovaries and placenta cause hyperæmia of conjunctiva and vulva and hyperæmia and thickening of the uterus. The epithelium of the uterus becomes higher and the connective-tissue cells of the mucosa vesicular. In estimating the significance of this latter work we must emphasize (1) that the results of various investigators are contradictory as to the active constituent in the ovary while some find the corpus luteum effective, the majority find it inactive or at least less active than other parts of the ovary. There are also discrepancies as to the effect of boiling and the effect of the medium of extraction on the efficacy of the extract. (2) It has been erroneously assumed by some investigators that cyclic growth processes in the uterus have been imitated through the injection of these substances. On the contrary it seems that the typical effects which the corpus luteum exerts in the living state have in no case been reproduced in these experiments. On the other hand they seem to establish the fact that circulatory effects and a turgescence condition of the uterus can be produced through injection of these substances and that the atrophy of the uterus following castration probably can be avoided. (3) It is uncertain how far the results obtained with extracts of generative organs are specific for

these extracts. Sufficient control experiments with other organs are as yet lacking. It seems, however, that thymus extract acts similarly to extracts of generative organs (50).

These experiments can at best supplement results obtained by means of better methods, but it is inadmissible on the basis of such experiments to invalidate conclusions which rest on an experimentally secure foundation.

#### VII FERMENTS IN THE OVARY AND UTERUS

A few authors investigated certain chemical actions of uterus and ovaries *in vitro* in order to throw light on the character of the substances given off by the ovary and transmitted to the uterus. Thus Halban and Frankl (53) and Aschner (54) found the uterine mucosa to contain a tryptic ferment which was apparently present in increased quantity during the premenstrual period. Halban assumes that this tryptic ferment is responsible for the decidual transformation of the uterine mucosa. It is however apparent that this investigator did not obtain the proliferative changes characteristic of true decidua but obtained merely a non specific swelling of cells such as alkali and trypsin produce in gelatin. R. T. Frank (55) showed in a very careful investigation that crepsin as well as amylase and lipase are present in the placenta. Schuckele (51) found in the ovary and in the uterine mucosa substances which inhibit coagulation of blood and produce hyperæmia. He believes that these substances originate in the ovary and are transmitted to the uterus and are responsible for the menstrual bleeding. While it is very probable that these substances play an important part in the menstrual hemorrhage, it is very unlikely that they originate in the ovary and are merely given off to the uterus.

In conjunction with Moyer S. Fleisher we found that the uterine mucosa and ovary of the guinea pig exerts the strongest fibrinolytic power of any organ in the body which we examined (56). The uterus of the rabbit also exerts a strong fibrinolytic power. The ovary of the rabbit, on the other hand is devoid of this power. We may therefore conclude that the fibrinolytic power of the uterus is not derived from the ovary but originates inde-



pendently in the uterine mucosa. It is very probable that the fibrinolytic and coagulation inhibiting substances are identical and that they are of importance in menstrual bleeding but it is quite evident that these substances are not identical with the substances sent from the ovaries to the uterus which are responsible for the cyclic changes in the uterus and for the prevention of its atrophy.

#### VIII. INFLUENCE OF THE OVARY ON THE MAMMARY GLAND

The relation between ovary and mammary gland is as yet incompletely analyzed. We know that, when castration is performed at an early period of life the mammary gland remains undeveloped and that it atrophies if castration is practiced at a later period in life. If ovaries are transplanted into young male guinea pigs the mammary gland begins to develop to form acini and even to secrete milk (Steinach 42 Athias 43). It is not definitely known at the present time which part of the ovary is responsible for this effect. Steinach, it seems to us on insufficient evidence assumes that the interstitial gland is responsible for this effect. Athias found that in such male guinea pigs into which ovaries had been transplanted and the mammary gland had grown, corpora lutea were absent in the transplanted ovaries. He assumes therefore that either the follicles or interstitial gland caused the proliferation.

Ancel and Bouin (57) as well as R. T. Frank and Unger (58) found in the rabbit a growth of the mammary gland concomitant with the development and growth of the periodic corpus luteum and they are inclined to attribute this growth to the activity of the corpus luteum. During pregnancy this growth is followed by the production of milk. This secretory action is attributed to Hildebrandt (59) and others to cessation of the growth stimulus by Ancel and Bouin (60) though apparently without sufficient basis to a so-called myometric gland which is found in the uterus during pregnancy or after experimental production of deciduomata.

In conjunction with Cora Hesselberg we (61) were able to show that the guinea pig the cycle of the mammary glands consists of

two phases analogous to the phases of the uterine cycle. The first phase, comprising the period of heat and the several days following ovulation shows mitotic cell proliferation of the gland. This first phase depends upon the absence of the corpus luteum, but upon the presence of another constituent of the ovaries. This phase can be accelerated through early excision of the corpora lutea. The second phase corresponding to the growth and activity of the corpus luteum, is not accompanied by proliferation of the gland only toward the latter part of this period proliferation is resumed and becomes especially frequent in cases in which simultaneously well preserved deciduomata and corpora lutea are present. During pregnancy mitotic proliferation of the gland appears only a little earlier than during the ordinary cycle unaccompanied by pregnancy. Experimentally accelerated ovulation during pregnancy is again accompanied by proliferation of the mammary gland. We may then assume that in certain respects the mammary gland of the guinea pig requires a stronger proliferative stimulus than the mammary gland of the rabbit. The relation between functions of corpus luteum and mammary gland is apparently not as simple as could have been assumed on the basis of observations in the case of the rabbit alone, especially if we consider with how great a regularity the mammary gland shows some proliferation in the guinea pig at the time of ovulation. During pregnancy the proliferation of the mammary gland is, at least in the guinea pig, much greater than during the ordinary sexual cycle.

The cause of the proliferation during pregnancy is not definitely established. Lane-Clayton and Starling (62) sought the substances causing proliferation and milk secretion in the embryonic tissues in the rabbit. R. T. Frank and Unger (58) showed that this effect of foetal extracts is not regular in the rabbit and is absent in the rat. Other investigators (Aschner and Grigoriu 63 Fellner 59) obtained proliferation of the mammary gland through extracts of placenta and ovaries, but corpus luteum extract proved ineffective in the hands of Aschner and Grigoriu.

We found (18) in the guinea pig aqueous corpus luteum extract without effect on the mammary gland while according to recent not yet published experiments R T Frank found that in rabbits the lipid bearing fractions of extracts of both placenta and corpus luteum were effective in producing proliferation of the mammary gland while in the rat both were ineffective. The rat seems therefore to behave toward extracts in a way similar to the guinea pig while the mammary gland of the rabbit seems to be much more responsive to the effect of extracts.

At the present time the mechanism underlying the cyclic changes in the mammary gland can be considered only as partly analyzed.

Quite recently we found (64) that the ovaries are of importance for the growth processes in the mammary gland in still another way. The function of the ovaries is to a great extent responsible for the development of cancer in the mammary gland in mice. If we castrate female mice at a time when they have already entered into the period of sexual maturity the incidence of cancer of the breast, which is by far the most frequent cancer in mice in strains with a hereditarily determined high tumor rate is reduced from approximately 60 per cent or 70 per cent to 9 per cent. We may attribute this effect of castration to the elimination of the cyclic growth stimuli which emanate from the ovaries and act on the mammary gland in the normal animal. It is uncertain which constituent of the ovary is responsible for this effect.

As we have shown the relations between ovaries and uterus are complex. Transitory organs like the corpus luteum and placenta enter into the play of mechanisms. It is now possible to separate experimentally the effect of the maternal and embryonal part of the placenta in these complex phenomena. Therefore a beginning in this direction has already been made. It will be necessary eventually to complete this analysis. In addition we must consider the possibility that the relation between uterus and ovaries represents a chain of connected phenomena of which the first and last members are uterus and ovaries the intermediate links being

formed by other glands of internal secretion or certain nervous structures. An analysis of these latter relationships however is outside the realm of the problems to be dealt with in our report.

#### SUMMARY

Without attempting to present a complete summary of this paper the following most important conclusions may be specially emphasized.

1 The ovary is a complex gland of which the most important constituents are follicles in various stages of growth and atresia and corpora lutea. In addition we find in some species interstitial gland and sometimes embryonic structures developing parthenogenetically from eggs.

2 Cyclical changes occur both in the ovary and secondarily in the uterus and mammary gland.

3 The primary cyclical changes in the ovary are in sequence follicle ripening ovulation, corpus luteum formation. In some species ovulation is accompanied by degeneration of all but the smallest follicles.

4 An elaborate self regulating mechanism controls ovulation. Normally the corpus luteum inhibits ovulation. During pregnancy the life of the corpus luteum is prolonged. Experimentally ovulation can be influenced at will accelerated by excising all corpora lutea or retarded by producing artificial decidualmata. The retarding action of the corpus luteum is chemical not mechanical.

5 The corpus luteum has a sensitizing action upon the uterus. This action can be analyzed by experimental methods. If the uterus is incised or mechanically stimulated at the time during which the corpus luteum is elaborating this growth substance maternal placenta (decidua) is formed. The mechanical stimuli therefore, assume in this respect the function which the ovum exerts under normal conditions. The form of growth response of each species is characteristic. The localization of sensitization varies in different species being limited to the uterus in rabbits and guinea pigs but distributed more widely in the human female. No specificity exists in the sensitizing substance.

given off by the corpus luteum as far as different individuals of the same species are concerned. The life period of experimental deciduomata is short except in pregnancy during which their persistence is prolonged.

6 Corresponding to and dependent upon the cyclical ovarian changes, uterine cyclical changes occur. The cycle consists of heat, growth with associated glandular activity regression and interval. Heat probably is due to maturation of the follicles and dependent upon the absence of the corpora lutea growth activity is the result of corpus luteum secretion regression marks the cessation of corpus luteum secretion, which is followed in the interval by a condition of rest. Pregnancy causing a persistence of the corpus luteum is characterized by an accentuation but not a prolongation of the active phase, and an inhibition of the uterine cyclical changes throughout gestation.

7 While it is possible to produce experimentally during pregnancy a new ovarian cycle through excision of the corpora lutea, such a new ovarian cycle is not followed by a new uterine cycle. During pregnancy a mechanism is at work preventing the uterine mucosa from responding to the stimuli given off by various ovarian structures.

8 It follows from 4 and 5 and 6 that the corpus luteum subserves at least two functions, inhibiting ovulation and producing a substance which causes growth in the uterus.

9 The ovary shows other non-cyclical functions. It has a trophic influence on the genitals and either primarily or secondarily determines the development of the secondary sexual characters.

10 The ovary likewise controls the development of the mammary gland. It exerts a trophic influence on this organ and determines its normal cycle. During heat and subsequent to ovulation proliferative changes occur these cease while the corpus luteum develops and functions.

11 The incidence of breast cancer in mice is greatly reduced by castration

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## TRANSPLANTATION AND RETENTION OF OVARIAN TISSUE AFTER HYSTERECTOMY

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THE purpose of this paper is to inquire primarily into the influence of ovarian tissue retained in the body after hysterectomy on the so-called ablation symptoms. In making such an inquiry we must clearly define the nature of ablation symptoms and consider what theoretical knowledge we have of their causation. We must determine from experimental and clinical evidence the anatomical fate of retained ovarian tissue and must observe whether or not important changes take place in the physiological action of such tissue. From clinical statistics we must discover whether or not the retention of ovaries has a beneficial or preventive influence on ablation symptoms. In like manner it is necessary to learn whether the anatomical and physiological changes in retained ovaries may not be productive of pathological conditions capable of serious harm to the patient. Finally we must weigh the evidence of possible good and possible harm from ovarian retention.

### I. ABILATION SYMPTOMS

Ablation symptoms may be classified as historic, traditional and modern. By his-

toric is meant that distressing symptom complex which in the earlier days of surgery followed a considerable proportion of castration operations, consisting of intense flushings, sweatings, palpitation, headaches, extreme and protracted weakness, sleeplessness and many other similar disturbances that persisted sometimes for many years. In addition to these vasomotor changes there were often associated hysterical and psychoneurotic manifestations that occasionally led to mental disorders of a still graver nature. Thanks to improved surgery serious sequelae like the foregoing are nowadays rarely encountered, for it has been shown that the more distressing symptoms of the artificial menopause are for the most part excited by disabling and discouraging postoperative complications, which were formerly of common occurrence after hysterectomy.

The traditional ablation symptoms relate to those physical changes which in the popular mind are supposed to take place after removal of the ovaries. Chief among these are an abnormal accumulation of fat, inevitable sexual insensibility and a general acquisition of masculine characteristics such as roughen-

ing and deepening of the voice, coarsening of the features and growth of facial hair. These need only to be mentioned as an unfounded belief deeply ingrained in the lay mind having its origin doubtless in a vague analogy to the changes produced by castration of unmatured animals.

The term modern ablation symptoms relates to the comparatively mild vasomotor disturbances that ensue after the extirpation of the uterus and adnexa by improved surgical technique.

In our use of the term ablation symptoms we shall refer for the most part to hot flushes for they alone are sufficiently distinctive for accurate statistical observation. There are to be sure certain other posthysterectomy manifestations sometimes observed independent of but usually associated with flushes the most important of which are sensations of alternate heat and cold, palpitation, feelings of anxiety, dizziness and sleeplessness. They are however extremely inconstant. They are common enough among women without pelvic lesions and are not infrequently seen after any surgical operation not involving the genital organs. Therefore they can hardly be regarded as unequivocal ablation symptoms in the same sense as hot flushes, the appearance of which is entirely and specifically characteristic.

Regarding the etiology of ablation symptoms it must be admitted that our knowledge is little more than theoretical. Walthard has interestingly ascribed them to a psychoneurosis resulting from overvaluation of minor discomforts. Such a state of mind he describes as a pathological mental habit. The condition is greatly exaggerated if there be an associated psychic distress as from self-depreciation on account of the loss of reproductive organs, or from marital difficulties caused by the patient's pelvic condition. Walthard shows how psychic pain may set up a cortical reflex in various organs of the body for example in the muscular and digestive systems. By analogy he argues that such reflexes may set up functional disturbances in the glands of internal secretion with consequent changes like those of ablation symptoms. Cannon's work on the effect of the emotions on the secretions of the adrenal gland and sympathetic systems is a striking substantiation of this theory. Walthard describes as psychosecretory such effects of the mind on the glands of internal secretion.

Although we cannot wholly accept Walt-

hard's theory that ablation symptoms are psychoneurotic in origin nevertheless, we can scarcely deny that his ideas offer a partial solution of the problem. On the basis of this theory it is easier to explain the fact that as a rule ablation symptoms are greatly intensified by discouraging postoperative complications or by mental distress, such as that over the loss of organs, and that such symptoms may often be made to disappear at once, on relieving the patient of her physical or mental disability.

Walthard's theory however cannot be accepted *in toto* for unequivocal ablation symptoms are often observed in patients, whose physical ills have otherwise been completely relieved by the operation and to whom the removal of the genital organs is a matter of great mental satisfaction.

Schickel has attempted to explain ablation symptoms on the ground that the elimination of the ovarian secretion, which is vasodilator in its action, allows a gradual and prolonged rise in the blood tension and that vasomotor symptoms result from this increase of pressure. He also showed that the blood tension may be reduced by the administration of ovarian extract. It was found however that ablation symptoms and rise in blood pressure do not always run parallel, that is to say each may occur independently of the other. Schickel explains this irregularity on the basis of individual differences in patients, especially with reference to the excitability of the sympathetic nervous system. He makes no attempt to explain the fact that ablation symptoms usually come on very soon after the operation, while the rise in blood pressure does not appear before several weeks.

Schickel encounters another difficulty in his observation that when one or both ovaries are left *in loco* after hysterectomy the vasomotor symptom-complex happens just as often as when the ovaries have been extirpated. These symptoms, he says, are extraordinarily similar to if not exactly like, ablation changes. He names them retention symptoms and ascribes them to products of ovarian secretion which, not having a normal outlet collect in the body and cause the characteristic disturbances.

Schickel's theory though suggestive, is nevertheless unsatisfactory for it is difficult not to believe after comparing cases exhibiting ablation and retention symptoms, that the symptom-complex in both cases is not only similar but identical and originates from the same cause. If this be true, how then can

we reconcile the fact that the same complex may be produced either by removal or retention of one and the same organ

In order to arrive at an answer to this question it must be borne in mind that the ovary is an integral part of two physiological systems namely the secretory and reproductive, between which it occupies so to speak, the position of a connecting link. On the one hand, the ovary is a member of the correlated chain of glands of internal secretion the integrity of each one of which is necessary for the proper physiological balance of the whole group. During the period of development before puberty the interrelation between the ovary and the other glands is of great importance during maturity up to the time of the menopause the ovary plays a subordinate but by no means an insignificant rôle. On the other hand, in the reproductive system the ovary is the predominant factor but it is not an independent factor for its proper function depends on its physiological association with the uterus and endometrium. Disturbances in either the secretory or reproductive system create reactive changes in the other. Familiar examples are the menstrual abnormalities attendant upon diseases of the pituitary thyroid and adrenal glands while the reverse action is seen in the anatomical changes of the same glands during pregnancy and their various constitutional manifestations often seen with dysmenorrhœa myopathies and other pelvic diseases.

Inasmuch as the normal function of the ovary is dependent on its physiological connection with the uterus a disturbance or severance of this connection supposedly produces an ovarian dysfunction, which in turn is likely to upset the balance of the other ductless glands thus creating in them a corresponding dysfunction. Hence the evidences of hypersecretion of the thyroid and adrenals for example in certain cases of dysmenorrhœa. Thus too a disturbance of the ovarian function from removal of the ovaries from the body with or without the uterus or from retention of the ovaries in the body without their uterine complement is likely to be communicated to the other secretory glands with corresponding dysfunctional symptoms. In

this way then both ablation and retention symptoms as well as those similar changes that appear in the course of various pelvic diseases are ascribed to reactive influences in glands other than the ovaries. Therefore the terms ablation and retention symptoms are inadequate and misleading. One would more correctly refer to the general complex as dysfunctional symptoms and to specific cases as dysfunctional ablation or dysfunctional retention symptoms.<sup>1</sup>

The vasomotor nature of the symptom complex is due to the fact that the secretory reaction is exerted chiefly on the sympathetic nervous system. The irregularity of the appearance of the symptoms is explained by individual variation in the power of adaptation to changes in the secretory system. Inasmuch as the ultimate effect is on the sympathetic nerves it is to be expected that in patients with a nervous predisposition or when postoperative complications or mental distress increase the nervous irritability the dysfunctional symptoms would be exaggerated and prolonged. Such we have seen to be the case.

That the majority of patients suffer comparatively slight inconvenience from the removal of the ovaries and many of them none at all is evidence of the subordinate part played by the ovary during maturity in the group of ductless glands.

The foregoing theory of the origin of ablation symptoms explains the apparently anomalous cases in which the symptom-complex is made completely to disappear by the removal of the ovaries. In such cases there exists a disharmony in the utero-ovarian function which causes reactive disturbances in the internal secretory apparatus. Extirpation of the uterus and ovaries removes the source of irritation and the glandular system resumes its normal balance. The following case illustrates this point extremely well.

A young woman of 23 single consulted me for continuous and troublesome hot flushes which were especially severe and associated with other nervous and vague discomforts at periods averaging

<sup>1</sup> The term *dysfunction* is employed throughout this article whenever the word "change" is used. It signifies the chemical nature of the secretion, similarly the word "disordered" secretion refers to disturbed or abnormal effect, irrespective of the cause of its production.

ing about five or six weeks. She had never menstruated. Examination showed a complete absence of the vagina. No internal genital organs could be felt in the pelvis per rectum. The patient was told that she probably had some ovarian tissue which by being unable to functionate properly was causing the trouble. An exploratory laparotomy was advised.

On opening the abdomen two entirely normal ovaries were discovered, each one at about the level of the lower pole of the corresponding kidney. In one ovary was a well-formed corpus luteum. Connected with each ovary was a tube and rudimentary strand of solid uterine tissue, forming a complete uterus didelphys with entire absence of the vagina. The ovaries and rudimentary uterus were removed. The operation was followed by an almost complete disappearance of hot flushes and with consequent improvement in general health and nerve control.

In this case the disharmony consisted in the association of a rudimentary uterus with fully developed ovaries so that normal function was impossible. The result was typical dysfunctional symptoms of the same nature and origin as those seen from ovarian retention after hysterectomy.

The following case also illustrates the restoration of normal secretory function by hysterectomy and removal of the ovaries.

A. T. age 45 two children one miscarriage with twins. Seen January 16 1915. Chief complaint severe menorrhagia, insomnia, hot flushes general nervousness. Examination uterus in position, normal contour slightly larger than normal. Operation January 19 1915 supravaginal hysterectomy with the removal of ovaries. Pathological examination of uterus and ovaries entirely negative. Hot flushes disappeared immediately after operation and did not recur. Completely regained nervous control.

In this case the dysfunctional secretory activity was evidently the result of a disharmony of function between ovary and uterus as shown by severe menorrhagia without anatomical lesion. The patient was cured by removal of both uterus and ovaries.

The theory that ablation symptoms are due to dysfunctional activity in the internal secretory apparatus has some support from experimental evidence though it has as yet not been indisputably proved. Cristofolletti and Adler produced by subcutaneous injections of small doses of adrenalin symptoms similar to those of the menopause i.e. rise in blood tension irregular pulse, blushing of

the skin headaches and feelings of anxiety. Adler found a greater reaction to adrenalin in individuals from whom the ovaries had been taken. Results of this kind are suggestive but by no means conclusive for none of the symptoms produced can be said to be specifically of the menopause type.

To the gynecologist, the practical point in the study of ablation symptoms is the question of the removal or retention of ovarian tissue in the course of hysterectomy operations. Theoretically we have attempted to show that the symptom-complex results from a breaking of the harmony of the utero-ovarian function. Upon this theory it is reasonable to expect that if the uterus be extirpated, dysfunctional symptoms would ensue whether the ovaries be removed or not. Let us now see whether or not this conclusion is borne out by clinical evidence.

## II POSTOPERATIVE RESULTS FOLLOWING HYSTERECTOMY WITH ONE OR BOTH OVARIES LEFT IN SITU

It is of course obvious that the leaving of ovaries in the pelvis after hysterectomy is feasible only in a limited number of cases. It is for example out of the question after operations for malignancy or extensive tuberculous of the pelvic organs. In cases of a pelvic inflammatory disease which is sufficiently destructive to require hysterectomy the ovaries should not be allowed to remain, even if there be considerable normal ovarian tissue for in these cases the surface epithelium has invariably been damaged to such an extent by adhesions that the organ is sure to become adherent again. An isolated ovary buried in adhesions is extremely liable to form retention cysts which may cause so much trouble to the patient as to require removal later. The operation of digging out an adherent cystic ovary from the depths of a pelvis in which hysterectomy has been done is a difficult and serious one. The following case illustrates the inadvisability of ovarian retention in cases of hysterectomy for pelvic inflammation.

N. D., age 34. Case of chronic pelvic inflammation. Had had a previous conservative operation. Operation supravaginal hysterectomy—removal

of left adnexa. Right ovary left *in situ*. Patient returned one year later with small postoperative hernia, painful cystic tumor in pelvis, and suffering from severe hot flushes. Operation: cyst of ovary densely adherent in pelvis removed with much difficulty on account of bleeding. Hernia repaired. Good recovery. Great improvement in hot flushes following operation.

Leaving in one or both ovaries is anatomically feasible in certain cases of small or moderate-sized myomata or in the myopathies without apparent lesion or in procidentia cases in which the method of removing the uterine body is adopted. Even under these favorable conditions it is probable that the surface of the ovary usually becomes adherent. The germinal epithelium is a very delicate structure and readily desquamates under comparatively slight inflammatory or circulatory influences. It is for this reason that the ovary has such a marked disposition to adhere to neighboring organs.

I have frequently had occasion to remove ovaries that had been retained at a previous hysterectomy operation and in every instance the ovaries have been found densely adherent degenerated, and cystic.

In addition to the tendency which the retained ovary has to form adhesions and cysts it also possesses the power of developing tumors which may be of a malignant nature. Experimental evidence demonstrates that if the ovary be left *in situ* with due care to preserve its blood supply it may continue to ovulate for a considerable period. In the course of time the functional activities cease. It must, however, not be inferred that the retained atrophied ovary loses its power of abnormal cell proliferation any more than does the atrophied ovary of the menopause. The following case illustrates the malignant fate of a retained ovary nine years after a hysterectomy for fibroids.

R. S. age 47. Had had operation nine years before. Removal of uterus for fibroid, both ovaries being left *in situ*. Examination showed large adherent tumor in pelvis. Operation, October 3, 1916 removal of large papillary cyst of right ovary very adherent to the intestines. Intestinal wall injured and repaired. Left ovary adherent small and shrivelled, removed with atrophied tube. Pathological examination malignant papillary cystadenoma of right ovary. Left ovary atrophied, but

germinal epithelium very prominent and active, dipping down into stroma and showing a papillary inclination. Evidently early stage of cystadenoma. Patient made good recovery from ether but a few weeks after discharge showed irregular masses in pelvis, probably recurrence of malignant disease.

I am indebted for the following case to Dr. Hugh Williams who consulted me during its progress.

M. B. age 25. 2 children, 2 miscarriages. Last pregnancy four years previous. Chief complaint menorrhagia and metrorrhagia, for which curetting two years before had given only temporary relief. Operation August 30, 1910. Vaginal hysterectomy. Both ovaries and tubes left *in situ*. Pathological report: sclerotic uterus with atrophied mucosa. Normal convalescence. Following operation severe menopause symptoms. Every twenty-eight days distressing moulins of menstruation with severe pelvic pain, headache and nausea. At these periods psychoneurosis appeared which gradually grew worse until they appeared in the form of insane outbursts each month. Retained ovaries painful and tender.

January 8, 1913 abdominal operation. Removal of both tubes, ovaries, and appendix. Pathological report: ovaries cystic, fibrous, corpora hemorrhagica. Normal convalescence.

Later history: Patient recovered immediately and completely from menopause and psychoneurotic symptoms. Is now perfectly well.

In this case the retained ovaries not only underwent anatomical changes that caused pain and tenderness but they also produced dysfunctional vasomotor and psychoneurotic symptoms of the most pronounced hysterical type. They were made completely to disappear by removal of the ovaries.

From the above cases it is sufficiently evident that an ovary retained *in situ* is by no means a harmless organ and that its retention may subject the patient to later trouble of a serious kind.

So far we have considered the retained ovary in relation to its anatomical possibilities. We will now regard it from a physiological viewpoint.

It is an extremely widespread belief among surgeons that the retention of ovaries *in situ* after removal of the uterus eliminates partially or completely the so-called ablation symptoms. At a meeting of the American Gynecological Society in 1910 at which the subject was fully discussed there was but one



dissenting voice to the recommendation by the readers of papers for conservation of ovaries after hysterectomy. Definite statistics on the comparative merits of conservation and ablation with special reference to symptoms of the surgical menopause are somewhat meager nevertheless, what testimony we have in the literature is very significant. Schlickele finds that when one or both ovaries are retained the vasomotor symptom-complex happens *just as often* as when the ovaries have been extirpated.

Walthard in a comparison of his own cases finds an improvement of only 2 per cent in retention over ablation.

Walthard again in a later article sums up the statistics collected by Sarwey of Tuebingen, Cemach of Munich and Senn of Berne and finds that in those patients whose uteri and ovaries have been removed only in from 1 to 2 per cent of all cases do the above mentioned symptoms appear more commonly than in those whose ovaries have been left behind.

Konstantinidis, in 134 cases of hysterectomy with retention of one or both ovaries, found that one half suffered from vasomotor, one third from trophic and one seventh from psychic disturbances.

My own figures are given in the table below in which a small number of retention cases is compared with a much larger number of total ablation cases with special reference to hot flushes. In this series the retention cases actually suffer by comparison as far as severity is concerned though the incidence of symptoms is almost identical in the two series.

Walthard and Schuckele both find that the symptoms appear in approximately 80 per cent of all hysterectomy cases, whether ovaries are retained or not. It will be seen that my results correspond closely to their figures.

In contrast to these figures are those of Dickinson who in a series of 163 cases in which ovaries had been retained reports that

80 per cent were free from the disturbances of the surgical menopause. These figures are not only far ahead of any others that have been published but they are even better than

those of the natural menopause, in which it is generally accepted that about one-half of all women experience vasomotor changes.

Notwithstanding the findings of Dickinson, my experience impels me to the conclusion that the retention of ovaries after hysterectomy insures only a slight improvement in the menopause symptoms over ablation, and that this slight advantage even if it exists at all, does not compensate for the dangers of adhesions with cyst formation, malignant degeneration, and physiological disturbances which the conservation of the ovaries entails.

### III. TRANSPLANTATION AFTER HYSTERECTOMY

On account of the prevailing superstition regarding the dire effects of removing ovaries, it is not infrequently necessary for the mental comfort of the patient to leave behind ovarian tissue even though the patient be warned that the retained ovary may cause later trouble. In order to meet this contingency and at the same time to avoid the dangers of leaving ovaries *in situ* the expedient was adopted of transplanting a section of healthy ovary. In the first cases the transplantations were made within the leaves of the broad ligament in the paracervical cellular tissue. This maneuver soon proved unsatisfactory for in 3 cases the transplanted tissue became cystic and painful. In one of these menstrual molimina appeared with profuse nosebleed, which the physician who reported the case to me regarded as vicarious menstruation. None of the cases were operated on for removal of the transplanted ovary although in one instance the operation was advised. In the light of these results, the transplantations were then made in the abdominal rectus muscle from which location the ovary might easily be extracted in the event of troublesome complications. In order to determine the possible influence of transplanted ovarian tissue on the menopause symptoms after extirpation of the uterus letters were written to each patient containing questions as to improvement in health from the operation, presence or absence of hot flushes following the operation whether they were few or many, diminution of sexual sensibility and any special increase of general nervousness. The

results of this inquiry are partly recorded in the table below in which it will be seen that the showing is actually not so good as in the cases where total ablation was performed. Making allowances for the discrepancy in the number of cases observed and for variations in patients answers to questions the conclusion is inevitable that when the uterus has been extirpated transplanted ovarian tissue probably has no marked influence one way or the other on the surgical menopause symptoms. This conclusion has also been reached by Tuffier.

Chalfant has recorded 17 cases of transplantation after hysterectomy the percentages of symptoms in which are appended in the table below. His results in this respect are strikingly similar to mine, except that he finds an improvement over his 40 total ablation cases.

Our experience with transplantation lends still further support to the theory that the so-called ablation symptoms are due to a breaking of the utero-ovarian harmony and that if the uterus is removed the retention of ovarian tissue either *in situ* or by transplantation is of little physiological value.

It must, however be borne in mind that if the uterus is not removed the utero-ovarian harmony may be retained for a time at least by transplanted ovarian tissue so that menstruation may continue and ablation symptoms be prevented. This has been proved a number of times but it is difficult to imagine under just what circumstances it would be advisable to leave the uterus by itself in the pelvis and transplant the ovaries to some distant part. Our experience has led us very definitely to the conclusion that when both ovaries must be removed the uterus also should be extirpated for an isolated uterus almost invariably causes trouble and frequently requires removal. Implantation of the ovaries does not in any way obviate this difficulty even though it may preserve menstruation for the limited period during which the ovarian graft retains its function of ovulation. The following case illustrates this point.

A G. age 30. First seen June 15 1914. Appendectomy nine years before. Six months before had had ovaries removed details of operation

not known. Subsequent developments showed that tubes and ovaries had been removed and ovarian tissue transplanted in abdominal fat on each side of median wound. *Menstruation had come on three weeks after operation and had appeared regularly since.*

Chief complaint continual pelvic pain. Lump in abdomen. Examination small uterus attached to abdominal wall adherent tender mass in left pelvis movable tender tumor in abdominal wall to left of scar.

Operation June 17 1914 hysterectomy. Lysis of omental and intestinal adhesions in right pelvis. Removal of cystic ovarian tissue from fat on left left of abdominal scar.

July 27 1914 Readmitted to hospital. Tumor had appeared in abdominal wall on right of incision one week after leaving hospital. Operation removal of cystic ovarian tissue from fat on right of median scar.

December 9 1915 Readmitted to hospital. Tender tumor of abdominal wall on left of incision where it had appeared six months before. Operation removal of cystic ovarian tissue in fat on left of scar.

In this case ovarian tissue seemed to be scattered through the abdominal fat and was indistinguishable until it had become cystic.

It has been found possible to restore the utero-ovarian harmony by heteroplastic transplantation in castrated women in whom the uterus has been left behind so that menstruation is resumed and ablation symptoms made to disappear. Operations of this kind are not universally successful as heteroplastic grafts do not always take on account of the physiological antagonism of blood and tissue that exists between different individuals.

As has been said above castration without extirpation of the uterus is an ill advised operation, and besides other discomforts is apt to be followed by historic menopause symptoms of the severest type. One not infrequently encounters patients who have received surgical treatment of this kind and for a certain number of such cases hetero-transplantation undoubtedly has a field of usefulness.

Notwithstanding the negative conclusions to which we have arrived as to the physiological value of retained ovarian tissue after removal of the uterus it is nevertheless necessary at times from sentimental reasons to conserve the ovary. In such a case is it better to leave one or both ovaries *in situ* or to transplant? Animal experimentation has

shown that an ovary retained in place with careful consideration as to its blood supply retains its anatomical functions much longer than does one that has been grafted (Kawasoje). So far as the secretory influence on the general organism is concerned the statistics presented in this paper seem to show an apparent advantage in favor of the ovary retained *in situ*. It is, however, the custom of the writer when conservation is imperative to forego this somewhat doubtful advantage and instead to graft a section of the ovary in the abdominal wall where its removal if necessary will be a simple procedure and not a serious major operation. It is done with the full conviction that the only possible benefit it can have is to relieve the mental distress of a patient whose mind cannot be disimbuod of an ill founded superstition.

#### IV STATISTICS

The appended table is the result of an investigation to determine the incidence and gravity of ablation symptoms. As stated above, hot flushes were taken as the standard for they are far more constant than other vasomotor symptoms, and are nearly always present if other symptoms occur. The number of cases of retained ovaries is too small for complete comparison. As there were only 10 personal cases to record, 16 of other operators were taken from the hospital records in order to make the list more valuable. Notwithstanding the small number of cases the percentage results tally so closely with those of Walthard and Schickele that they are at least significant.

In studying the cases of total ablation a number of observations were made which are of special interest.

Hot flushes were reported by many patients who had passed the natural menopause at the time of the operation. This fact is evidence that the ovary retains its influence as a secretory organ long after ovulation ceases. It is also confirmatory of the theory now generally accepted that there exists in the structure of the ovary outside of the corpus luteum, an important source of its internal secretion.

There is a considerable difference of opinion as to the influence of age on the severity

of artificial menopause symptoms. Pokk, Dickinson Chipman and others assert that the younger the patient is the more severe the symptoms. Walthard on the other hand finds that the age makes no difference. In our series the severest symptoms appeared most commonly in women approaching or passing through the natural menopause, that is to say between the ages of 40 and 50. Thus we have ascribed to the greater instability of the nervous system at the critical period of life.

In a comparison between the symptoms of the surgical and the natural menopause we find that the disturbances of the natural menopause are far more complex than in the former ranging as they do from mild vasomotor changes to serious psychoneuroses. There is also a less definite time limit to their duration. The surgical menopause symptoms on the other hand have a greater incidence (i.e. 80 per cent instead of 50 per cent). Their average duration is three to four months. In general patients suffer less from the artificial than from the natural menopause.

TABLE OF STATISTICS

Operation	Per Cent
Total ablation (33 cases)	
No hot flushes	20
Few hot flushes	42
Many hot flushes	38
Total incidence of hot flushes	80
One or both ovaries left <i>in situ</i> (26 cases)	
No hot flushes	19
Few hot flushes	19
Many hot flushes	6
Total incidence of hot flushes	6
Transplantation (53 cases)	
No hot flushes	10
Few hot flushes	51
Many hot flushes	37
Total incidence of hot flushes	90
Chalazal transplantation (7 cases)	
No hot flushes	14
Few hot flushes	70
Many hot flushes	9
Total incidence of hot flushes	83

Walthard. Incidence of menopause symptoms 1 per cent less in cases of retained ovaries.

Schickele. Incidence of menopause symptoms the same in cases of retention and ablation.

Connach, Sarvey, Senn. Incidence of menopause symptoms, or per cent less in cases of retained ovaries.

Konstantinidis. 134 cases, one or both ovaries retained. Vasomotor symptoms, 50 per cent. trophic disturbances, 33 1/2 per cent. psychic disturbances, 1 per cent.

Dickinson. Incidence of surgical menopause symptoms in 163 cases—one or both ovaries retained—20 per cent.

Tuffier. Incidence of menopause symptoms after transplantation, 50 per cent.

Natural menopause. Incidence of symptoms, 50 per cent (Schickel).

## V CONCLUSIONS

1 Specific surgical menopause symptoms consist chiefly of vasomotor disturbances in the form of hot flushes

2 Theoretically vasomotor changes of the artificial menopause are due to a break in the utero-ovarian functional harmony by which the physiological balance of the glands of internal secretion is upset with consequent dysfunctional activity

3 After extirpation of the uterus vasomotor disturbances ensue with approximately equal frequency whether the ovaries be retained *in situ* totally ablated or transplanted.

4. Retention of ovarian tissue after hysterectomy is of little or no physiological value and may be productive of serious harm to the patient.

I am indebted to Miss H J Ewin supernumerary of the Free Hospital for Women for sending letters of inquiry to patients and tabulating the answers from which the personal statistics contained in this paper were compiled

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## THE PREPARATION AND STANDARDIZATION OF OVARIAN AND PLACENTAL EXTRACTS

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ANYONE who has read the various articles and monographs that have appeared in the literature in the last few years on the internal secretion of the ovary or placenta has no doubt been impressed by the great disparity of results obtained with extracts of these organs. This also obtains for the other glands that possess an internal secretion with exception of the adrenals. One investigator will arrive at seemingly beautiful results with an extract of a certain endocrine gland, while another will obtain a result exactly opposite with an extract of the same gland. One investigator may isolate from the same gland two products, whose action is antagonistic. Another research worker will try to confirm the work of these others and obtain negative results if indeed he does not get results different from those he is attempting to duplicate. The reason for this difference is that each one has made an extract by a different method and in a different way.

The need therefore for more uniform methods in the preparation of ovarian and placental extracts at once becomes apparent, for in no other way can the results of the different research workers and clinicians be compared. The tangible data both in the laboratory and in the clinic, are at best small. At present results obtained from extracts of the entire ovary or from the yellow body alone without note of whether aqueous alcoholic, or ethereal extraction is employed, are reported. The results will of course vary and are not comparable. All these differences and annoyances will disappear as soon as the active principle of the ovary and placenta is isolated. But until then it would be much better if some uniform method for the preparation and the standardization of ovarian and placental extracts was formulated.

Perhaps a short review of some of the more important articles on the preparation of ovarian and placental extracts and a descrip-

tion of the attempts made to isolate their active principle may be of aid in showing the absolute necessity of a more uniform method of preparation. It is only within the last ten years that an attempt has been made to isolate the active principle of the ovary and placenta, especially the former. Before that and even up to the present time, the desiccated product of the ovary or corpus luteum has been given to allay symptoms referable to some disturbance of the internal secretory mechanism of the ovary. Among the first to attempt to make an extract that would contain the active principle of the ovary was Iscovesco. He investigated as early as 1908 the action of the so-called "lipoids" obtained from the red blood corpuscles, the hypophysis, the kidney, the suprarenal capsules, the ovaries, the testicles, and the corpora lutea. He found that the lipoids obtained from these sources exerted a certain action on the female genitalia and discovered at the same time that there were two classes of these lipoids, classified according to their action. One which he called homo-stimulating had an action on the same organ from which it was derived and the other called hetero-stimulating had an action on different organs. This division was purely arbitrary as he discovered later.

Of special importance are the two lipoids which he characterizes as H F b. and V D c., both being obtained from the ovary. The latter he was able to isolate from the corpora lutea. His technique in preparation as given in his paper is briefly as follows: The fresh organ is finely pulped and the pulp thrown into three times its volume of 95 per cent alcohol, in which it is allowed to remain two hours. This is then filtered, set aside to extract the lipoids and is designated as Fraction I. The residual pulp is desiccated at 40 degrees, pulverized, and treated with different solvents. First, it is extracted with sulphuric ether and this is called Fraction II of the "lipoids." The residue therefrom is dried, powdered and treated with acetone in the same manner which gives Fraction III.

\*Comp. rend. du Soc. Biol. 911, 1902, 812.

Further extraction with the resulting residue gives Fraction IV and, lastly with alcohol Fraction V is obtained. All these fractions being prepared their subdivision and purification follows. For example, with Fraction II the ether extract is dissolved in petroleum ether giving an insoluble portion A which is small in amount and a soluble portion B which constitutes the major part. This latter is dehydrated and redissolved in ether. There remains then an insoluble part which is removed by the centrifuge. The clear supernatant solution is then thrown into about ten times its volume of acetone, pure and free from any acid and allowed to stand in the refrigerator 24 hours. At the end of this time an abundant precipitation will be found in the bottom of the receptacle, which when filtered, constitutes portion C. The acetone solution is concentrated and put into the refrigerator giving after cooling a yellowish white mass which is portion D. The remainder of the acetone solution, which has passed through the filter is then completely dried and the precipitate is dissolved in boiling alcohol. All should dissolve, after which it is cooled for 24 hours giving portion E and a dissolved portion F. Each of these fractions (A B C D E and F) thus isolated, is far from being considered as chemically pure and each must be dissolved in petroleum ether ordinary ether cold alcohol, and finally in warm alcohol. There is obtained by this means the series a, b, c, d, of the corresponding substances. The same procedure is gone through with Fractions III, IV and V. Each fraction was tested upon animals and only those which produced a rapid growth of the uterus were considered active.

Thus it will be seen from the careful and painstaking work of Iscovesco that when an extract of the ovary corpus luteum or of the placenta is used in laboratory experiments or in the clinic, care must be exercised in obtaining the active fraction of the extract or the vital part of the organ may be left behind on the filter paper and thrown away. Concerning the physiological action of these fractional extracts of Iscovesco and the results obtained by him in the laboratory and in the clinic, no mention will be made. Those interested in this part of his work, may consult his recent articles in literature.

According to his technique outlined above, the active substance, which he describes as II F b, might briefly be considered as an ether extract of the dehydrated organ (ovary) soluble in acetone (at ordinary temperature) having further been purified by boiling alcohol, concentration and extraction with petroleum ether. The other substance V D c, appears to have been obtained from the residue remaining after treating first with alcohol, then with ether then with acetone followed by

chloroform and finally with alcohol again. This alcohol soluble substance is then presumably purified by solution in petroleum ether resolution in ether and precipitation by acetone and in turn further purified by solution in petroleum ether or ordinary ether and cold alcohol. The substance then is acetone insoluble, whereas his previous substance II F b is soluble in acetone.

Herrmann followed the plan of Iscovesco in the preparation of ovarian and placental extracts and published his article early in 1915. Herrmann believes that he has succeeded in separating the active substance of the corpus luteum and of the placenta as a specific chemical substance. He attempted to prove this clinically and on animals. Many colored figures are appended to his article and his results if true show wonderful changes from only a few doses of his so-called active principle.

His method of extraction, while not identical with that of Iscovesco given above will not be described *in toto* at this time. He was able to obtain three fractions by his method and these were further purified by distillation and tested. It was found that the so-called middle run produced a thickly viscous body which represents as he believes the real active principle of the ovary. This active substance, as further described by Herrmann, is a yellowish glistening oil, which is solidified by cooling, but otherwise remains thickly viscous. It gives a very decided cholesterol reaction. It becomes brown when exposed to the air apparently by taking up oxygen, and is composed of three elements, carbon, hydrogen, and oxygen. The body is a cholesterol derivative. It is soluble in alcohol, ether petroleum ether acetone and benzol, but is insoluble in water.

Herrmann found the same active substance with identical physiological properties in the placenta as well as in the corpus luteum. However one placenta contains more of the active substance than one corpus luteum. The method of preparation is the same in both cases.

Seitz, Wintz, and Fingerhut found that the corpus luteum contained two bodies. One, which they designated as luteo lipid, has an inhibitory action on the blood and injected subcutaneously before and during the menses lessens the flow and shortens it. The other body they call lipamin soluble in water a luteo lipid or lecithin albumin which causes when injected into animals an increased growth of the genitalia. Subcutaneously injected in women, it causes the appearance of the menses in cases of amenorrhea. "Luteo lipid and

lipamin are antagonistic bodies and regulate the course of the menses. Their method of extraction is given in an indefinite sort of way. They obtain the various lipid fractions by extraction with alcohol, chloroform, ether and acetone. By later evaporation, redissolving and extraction they obtained the two antagonistic bodies mentioned above.

A hasty review of the methods of these research workers (Iscovesco, Herrmann, Seitz et al.) shows that they all used practically the same method of extraction and as far as can be gleaned from their clinical and experimental reports they arrived at about the same results. However the difference may be due to the fact that Herrmann obtained his so-called active substance in a purer state. These investigators at least used a certain definite method of extraction and their resulting products could be tested experimentally and clinically with a view of producing certain definite physiological and anatomical results.

Other workers, who have reported results obtained with ovarian or placental extracts have been too prone to give the clinical results secured with what they loosely call, an extract. This may be an aqueous alcoholic, or ethereal extract or as often happens, it is not an extract at all but simply the dried gland in the form of a desiccated powder. It should be clearly borne in mind that the kind of extract must be mentioned if the work is to prove of any value to others. A qualifying adjective such as ethereal, aqueous if properly employed may sufficiently designate the method of preparation. Not only is uniformity of preparation desirable but some form of standardization of the resulting products is necessary to obtain extracts of the same strength and action. Many of the failures to produce the desired effect are due to a lack of proper standardization of an otherwise perfect product.

In order to perfect a proper preparation and later a suitable method of standardization some research work was undertaken by the writer during the last two years. Up to the present time it can definitely be stated that no ideal method of preparation has been formulated and, until that is accomplished, the standardization of the product will not

be attempted. Various forms of extracts of ovary or corpus luteum of the ovary minus the corpus luteum (ovarian residue) have been made by exact chemical methods and the resulting extract tried on animals. The results have all been negative. One extract, a powder soluble in water has been obtained and clinically it has seemed to be active in some conditions i.e. disturbances of the artificial or the physiological menopause. But, in this connection, the results are too vague, ephemeral and transitory hence conclusions drawn therefrom do not have much value.

For example, a few ampules of the soluble extracts are given or sent to Doctor A. with the request that he try its action upon the disturbances of the menopause when a suitable case presents itself. Later Doctor A. has a patient who says that she is suffering from flushes of heat, insomnia, etc. Doctor A. makes an examination and finds no pelvic pathology. But upon the statement of the patient he injects an ampule of the soluble corpus luteum. In a day or two he repeats the injection. After a few injections Doctor A. asks the patient if she is feeling better and the patient not wishing to offend Doctor A. or thinking that she does feel better answers in the affirmative. Doctor A. continues the treatment and later reports this case as one cured.

Results based upon the statement of the patient, must be considered with extreme care. Yet that, practically today is all the data upon which judgment can be passed as to whether a preparation or extract of the ovary has any therapeutic action. There are many factors in the preparation of an extract which may have an important bearing upon its therapeutic activity such as the freshness of the material, the purity of the chemicals, proper temperature, avoidance of very high or very low degrees of heat or cold. Variations in all or any of these may tend to render the resulting extract inert or cause it to produce results that are due to faulty preparation.

In this connection mention will be made of Rosenheim, who reported his work on the pressor principles of placental extracts. Rosenheim was attempting to confirm the work of Dixon and Taylor who claimed that alcoholic extracts of human placenta contained substances which on intravenous injection

produced a rise of the blood pressure and a contraction of the pregnant uterus

Dixon and Taylor's method of preparing these extracts consisted in mincing fresh human placenta, covering it with absolute alcohol and filtering after some time. The filtrate was evaporated and again taken up with absolute alcohol. The residue of the last extract dissolved in saline solution, was injected intravenously. Rosenheim thought that the effect of the injections seemed to suggest the presence of adrenalin or a similar substance. Trying to prove this he found that the active principle was not identical with adrenalin. Rosenheim made alcohol ic extracts in several ways and found that the normal human placenta did not contain any pressor principle. Next he made three different extracts as follows. In the first the fresh minced placenta was barely covered with alcohol to allow putrefaction to take place. In the second the fresh minced placenta was shaken up with one liter of saline solution saturated with chloroform and kept for four days at room temperature and in the third the fresh minced placenta was mixed with absolute alcohol (1000 cubic centimeters of minced material to one liter of absolute alcohol). Rosenheim found that the first extract (above) contained a strong pressor principle, while the second and third did not or to quote his table

Conditions of Experiment	Results
A. (No. 1 above) Extract after free putrefaction.	Strong pressor effect.
B. (No. 2 above) Extract after autoclaving.	Total absence of pressor effect.
C. (No. 3 above) Extract of fresh organ.	Total absence of pressor effect.

Rosenheim was later able to identify this pressor principle of Dixon and Taylor as belonging to the amines and it probably is derived from the amino acids (leucine and tyrosine) the cleavage products of proteins.

Barger and Walpole came to practically the same conclusions in their work upon putrid meat, i.e. that it contains a pressor principle

Five extracts of the placenta were prepared by the writer and their action tested on the blood pressure and upon the isolated uterus as well as by injection into animals (rabbits). These extracts were prepared as follows

Number one was an aqueous extract obtained by exposing the minced placenta to distilled water, slightly acidulated. The resulting fluid was boiled with acetic acid to precipitate the coagulated proteins, filtered, evaporated, and distilled water added to bring it up to its original volume. This solution was passed through a Berkefeldt filter and filled into 1 cubic centimeter sterile ampules.

Number two was obtained by placing in a wide mouthed bottle 725 grams of minced placenta pulp. This mixture was allowed to stand at room temperature for four days loosely corked. Then 725 cubic centimeters sterile distilled water added mixed and filtered and the filtrate boiled with acetic acid. This was filtered while hot and the filtrate cooled and evaporated to more than one-half its volume. Sterile distilled water was added to bring the amount up to 725 cubic centimeters the original volume. This latter was next passed through a Berkefeldt filter and filled into 1 cubic centimeter sterile ampules.

Number three was prepared by taking 400 grams of minced placental pulp and adding to it 400 cubic centimeters of normal salt solution, saturated with chloroform. This was loosely corked and allowed to stand at room temperature for four days. It was then filtered and the filtrate boiled with acetic acid to precipitate the coagulated proteins. This was again filtered while hot, cooled and evaporated to less than one half its volume. Sterile distilled water was added to bring the amount up to 400 cubic centimeters the original volume. It was then passed through a Berkefeldt filter and filled into 1 cubic centimeter sterile ampules.

Number four was prepared by adding 400 cubic centimeters of absolute alcohol to 400 grams of minced placental pulp. This was allowed to stand for some time at room temperature in a bottle loosely corked. Then the whole was filtered, the filtrate boiled with acetic acid, filtered through paper and evaporated to less than half of its volume. Sterile distilled water was added to make 400 cubic centimeters the original amount. This was passed through a Berkefeldt filter and filled under sterile conditions into 1 cubic centimeter sterile ampules.

Extract number five was made by taking about 500 grams of minced placental pulp which was placed in a large mouthed bottle. This was allowed to stand in the incubator loosely corked, for several days. The mixture was shaken every two or three days. Then it was filtered and treated as the others (Nos. 1 to 4) and filled into sterile 1 cubic centimeter ampules.

These five extracts were submitted to Mr. L. W. Rowe to be tested on the isolated uterus of the guinea pig and upon the blood pressure of a chlorotonized dog. Mr. Rowe reported as follows: all five extracts contracted the isolated uterus of the virgin guinea pig when administered in sufficient quantity. About 0.25 cubic centimeters of the undiluted sample was necessary in each case to produce an appreciable contraction. The action of No. 5 and No. 2 seemed a little stronger than that of the others, and this was due to the fact that these extracts were partly decomposed. All meat extracts will contract the



isolated uterus if they are sufficiently concentrated and this action is more marked if the composition or partial decomposition has taken place.

The effect of these extracts upon the blood pressure was not very marked nor characteristic. In most instances the blood pressure fell slightly but this was more marked with No 5 which action was no doubt due to the very evident decomposition of this sample. The results of these tests indicate that placental extracts do not contain a pressor or marked oxytocic principle.

The action of these extracts (Nos 1 to 5) upon animals when injected intraperitoneally was negative. A large number of injections produced no macroscopic effect upon the internal or external genitalia of the animals injected. There was no anatomical difference between them and the control animals.

From a review of the more recent literature from the animal experiments thus far undertaken with extracts of the corpus luteum, ovary and placenta and from the different methods employed in making these extracts the following conclusions seem justifiable.

1 A more uniform method of preparing extracts must be instituted.

2 Some method for the standardization of these extracts must be discovered in order to facilitate the comparison of the results of the different laboratory workers and clinicians.

3 Many results obtained in the laboratory

or in the clinic are due to the faulty preparation of extracts.

4. The isolation of the active principle of the ovary and the placenta will clear up many if not all of these mooted points.

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## THE PLACENTA REGARDED AS A GLAND OF INTERNAL SECRETION

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FROM the days of antiquity it has been known that the placenta acts as intermediary between the maternal organism and the foetus. Only in recent years, however, has another function been ascribed to this organ, namely that of a gland of internal secretion. The first comprehensive expression of this view was published in 1905 by Halban.

1. *Halban's theory.* Joseph Halban (1) published an elaborate paper entitled *Die innere Sekretion von Ovarium und Placenta und ihre Bedeutung fuer die Funktion der Milchdruese*. The author based most of his deductions upon the interpretation of clinical facts, some of them from his own experience, others gathered from various sources, though not a few of the gaps in his evidence were bridged by facts obtained from animal experimentation. The work of many investigators performed during the last decade has confirmed and elaborated many of the deductions made by Halban and has placed the major part of his hypothesis upon a firm basis of fact. The following is a brief resumé of Halban's theory.

Both the puberty impulse (growth) and the menstrual stimulus to the uterus and breasts (in the breast, monthly swelling, colostrum formation, vicarious menstruation noted in virgins) are derived from the ovaries. Though the initial pregnancy impulse is originated by the ovum,<sup>1</sup> breast hypertrophy and later milk secretion is not interfered with by castration during pregnancy. On the other hand, both uterus and breasts continue their hypertrophy after foetal death, or during the growth of a hydatid mole without foetus. Consequently, it must be the placenta (foetal trophoblast or chorion epithellum) and not the foetus which elaborates the pregnancy growth substance.

The foetus of both sexes becomes sensitive to the placental stimulus in the eighth and ninth months of intra uterine life. This is shown by hyperplasia of uterus and breasts in females, and of prostate and breasts in males (Bayer 3, Schlachte 4). The geni-

tal hemorrhages noted in new born female infants (occurring in 0.35 per cent) Schukowski (5) a few days postpartum are due to the sudden withdrawal of the placental stimulus, as is the puerperal involution of uterus and prostate which reaches its completion about three weeks after birth.

That the placental influence is a chemical stimulus acting by way of the blood stream and not a direct local stimulation is proved by the uterine reaction which occurs in ectopic pregnancy.

From these observations Halban concludes that the chemical products of both the ovary and of the placenta produce hyperamla and uterine menstrual (or decidual) reaction and that both likewise exert an influence on the breasts. He further draws the deduction, unwarranted by his evidence, that liver changes in eclampsia etc. are due to placental influences and that the ovary during pregnancy loses its trophic protective power over the genitals, its function being vicariously assumed by the placenta.

2. *Influence of placental extracts on uterus and breasts.* Before attempting an analysis of Halban's theorems it will be best to present what is known today of the action of the placenta *per se*, unclouded by any possible ovarian influence. Thus most simply can be demonstrated the evidence upon which the placenta can be called a gland of internal secretion. The earlier experimental work as that of Claydon and Starling (6), Foa (7) and Basch (8) who used weak aqueous extracts of homologous or heterologous placenta can be dismissed as inconclusive (9).

Iscovesco (10), Fellner (11), Aschner (12), Seitz, Wintz and Fingerhut (13), Herrmann (14), Frank and Rosenbloom (15) however employed the concentrated fat soluble fraction of placental extracts which produces a strong and unmistakable reaction.

Subcutaneous injections of either aqueous or saline emulsions of the lipid or solutions in oils or alcohol cause enormous and rapid hyperplasia of the uterus. Both mucosa and musculature participate in the increase. This effect is obtained within 6 to 8 days in castrated animals where ovarian influence can be definitely excluded. Rabbits, guinea pigs,

<sup>1</sup> In the uterus this certainly does not hold good. The work of Leo Loeb (1) has shown that the chemical action of the corpus luteum plus the local uterine irritation exerted by any foreign body (or by injury to the uterine mucosa) can produce the atrophic reaction. Various authors have also elicited mammary breast hyperplasia by means of corpus luteum extracts alone.

Although Iscovesco used only ovarian extracts, his work should be considered the basis of all the investigations that followed. The discrepancy of corpus luteum and placental lipoids will be emphasized in succeeding paragraphs.

and rats show the same reaction. Similar though less marked effects are produced through introduction of the extract by mouth.<sup>1</sup>

A similar and equally rapid hyperplasia is exerted upon the breasts of rabbits. The nipples increase in size the glandular tissue hypertrophies. If the stimulus is prolonged colostrum can be expressed. The breast of the rat and guinea pig is less susceptible.

The uterus and breasts of these laboratory animals (rabbits are to be preferred because the breast reaction which can be followed without at once sacrificing the animal, is most plainly evidenced in rabbits) furnish a reliable biological test for testing the potency of the extracts.

3 *Chemistry* Our knowledge of the chemical composition of placental extracts is in a state of chaos. Iscovesco (loc. cit.) working with ovarian extract devised a complicated method of purification based upon elective solubility in various fat solvents. Herrmann, using corpus luteum and placental material (loc. cit.) published a still more complicated method depending upon extraction *in vacuo* elective solubility and fractional distillation with superheated steam. Neither of these authors judging by our experiences (*vide infra*) appear to have obtained a substance free from impurities.

The writer successively in conjunction with three biological chemists (Dr J Rosenbloom, loc. cit. Mr O I Lee and now with Mr P M Giesy) has for the last two and one-half years been engaged in attempting to isolate the active principle. Our attempts have not been crowned with success.

The knowledge obtained to date by our investigation may be summarized by stating that the potent crude extract which is obtained by continuous extraction with alcohol is a dark, semi-liquid mixture which resists high degrees of heat (350 C) strong acids or alkalis and saponification without loss of potency. It either oxidizes or polymerizes on standing gradually losing its activity. It is fully soluble in 95 per cent alcohol, partially so in chloroform ether oils and in

benzine (the active fraction at times following the benzine insoluble portion). The activity persists after removal of cholesterol and indol, which may be regarded as contaminations. The active substance has not been sufficiently purified to permit of analysis. Our attempts to duplicate Herrmann's work leads us to conclude that his final product was a mixture and not a single compound.

#### 4 *Similarity of corpus luteum and placenta.*

In agreement with Herrmann (loc. cit.) we have found that the active principles obtained from the corpus luteum and from the placenta can be extracted by identical methods chemically have identical properties and biologically produce identical results upon the uterus and breasts. Although the quantitative yield from corpus luteum is far richer than from the placenta placental material (human) is so much more readily obtained in large amounts that we have mainly used the latter in our work.

Whether the two are merely similar or are identical cannot be decided until both are isolated as chemical entities unless clear cut specific differences in physiological action can be shown. No such differences in action have as yet been discovered.

5 *New physiological facts* (a) Placental extract causes hyperplasia of transplanted portions of the uterus as well as in the uterus left *in situ*.

b The action is not diminished by removal of the adrenals, pancreas, or thyroid or combined removal of thyroid and adrenals.

c The ovaries are not stimulated by the extract.

d The atrophic uterus of castrated animals responds readily to the stimulus of the placental extract, even after long periods of time have elapsed (The longest period was 16 months after castration.)<sup>2</sup>

6 *Source of the placental hormone* The main function of the placenta unquestionably pertains to the exchange of nutrient substances from the mother to the foetus, and to the elimination of waste products of the foetus in a reverse direction. The fulfilment of this function accounts sufficiently

<sup>1</sup> The weight of the uterus compared with the weight of the uterus of normal control animal of the same body weight may reach 2 to 3 times that of the control.

<sup>2</sup> Details of the preceding experiments will be published in subsequent articles.

for the histological structure of the placenta, which is characterized by a labyrinth of sinuses lined by fetal cells. Therefore it does not follow in this instance because an intimate relationship between blood channels and cellular components exists a distribution usually characteristic of glands of internal secretion that the placenta must be a ductless gland. If further the apparent identity of composition and action of corpus luteum and placental secretion is considered and the well known abhorrence of the organism to unnecessary duplication of function is kept in view the question may logically be propounded whether the placenta does not act merely as a storage reservoir for the active principle elaborated by the corpus luteum during the earlier part of pregnancy. During the latter half of gestation the yellow body histologically has the appearance of an involuting functionless gland. No proof in substantiation of this hypothesis can as yet be adduced.

#### SUMMARY

1 The experimental work of the last decade proves that Halban was correct in ascribing to the placenta an action upon the uterus and breasts.

2 Placental extracts (mainly the lipid fraction) rapidly induce hyperplasia of the uterus and breast (gland tissue and nipples) in castrates or in non-castrated animals.

3 The chemical substance which induces these changes is thermostable very resistant

to strong alkalis and acids and completely soluble in 95 per cent alcohol.

4 The substance appears identical in its physical chemical and biological properties with a similar substance obtained from the corpus luteum.

5 The substance can exert its influence in the absence of the thyroids adrenals pancreas or in the absence of thyroid and adrenals combined.

6 In view of the apparent identity of corpus luteum and placental substance the question arises whether the placenta acts merely as a storage reservoir for corpus luteum secretion during the latter half of pregnancy or whether the placenta elaborates a hormone of its own.

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## RELATION OF THE SEX GLANDS TO METABOLISM

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**I**N a certain proportion of women at the time of the natural or artificial menopause there is a considerable gain in weight. In the lay mind at least, this tendency to adiposity is as intimately associated with the other changes that make up the phenomena collectively known as the menopause, as the assumption of the graceful lines of the female figure is linked to the onset of puberty. Not only at the beginning and end of sexual life are there changes in the general metabolism indicating the action of a specific internal secretion from the ovary but in pregnancy especially in the first half at a time when the muscular activities of the woman are not seriously interfered with there is often a decided gain in weight with changes in the physical contour of the limbs due to the deposition of fat. This occurs at a time when the functional activity of the ovary is disturbed by the growth of the corpus luteum. Near the end of pregnancy on the other hand when the functioning period of the corpus luteum is on the wane there has been shown to be an increase in the metabolism not entirely accounted for either by the increased weight of the mother or the needs of the growing fetus.

The increase in fat production following castration is commonly made use of by stock breeders in preparing their product for the market.

There is clinical evidence that the ovary exerts a control in the metabolism of phosphorus and calcium. In osteomalacia there is diminution in the loss of these substances after removal of the ovaries and improvement seems to follow the operation.

In an attempt to establish scientifically the treatment of osteomalacia by oophorectomy as originally suggested by Fehling, Curatulo and Tarulli calculated the respiratory metabolism before and after castration of one female dog and two mice. They used a small modification of the oft apparatus. The dog showed a gain in weight after the operation of 17 per cent and a diminution of the carbon dioxide excreted of 34 per cent. Both the mice showed a gain in weight after castration and a

marked diminution in the oxygen consumption. These observers also estimated the phosphorus excretion in the urine of two dogs and found a diminution in the phosphorus-loss after removal of the ovaries.

In 808 Loewy and Richter in an effort to determine if the sex glands have a specific internal secretion affecting metabolism, examined by the Zuntz-Geppert principle the respiratory air of a male and female dog before and after castration.

For a female dog weighing 15.8 kilograms, four hourly observations established the normal oxygen consumption at 6.1 cubic centimeters per kilogram minute. Eighteen days after removal of the ovaries, observations were again made and the average of five periods during the course of 31 days showed an average weight of 15.5 kilograms, and the oxygen consumption of 5.8 cubic centimeters per kilogram minute. The next series of observations extended from ten weeks to 3½ months. The weight was increased over 14½ kilograms and the oxygen diminished over 15 per cent.

In the last period, four to six months after the operation, there were three observations showing an average weight of the animal of 17.0 kilograms, an increase of 1.2 kilograms, and the oxygen diminished to 4.8 cubic centimeters a reduction of the oxygen consumed per kilogram minute of 20.6 per cent.

Between the second and last series of experiments, the dog was fed oophorin tablets, and after 96 tablets had been taken, there was a gain in the oxygen consumption of 37.6 per cent above the normal. If the gain is compared with the reduced consumption following the castration, it amounts to 67.7 per cent.

RECAPITULATION OF THE LOEWY AND RICHTER TABLES

	Weight	Air Reduced	O <sub>2</sub> Consumed (ccm) per min.	O <sub>2</sub> per kg. per min.
	kg.	ccm.	ccm.	ccm.
Normal	15.86	302	87	5.483
First period 3 weeks	15.54	248	66.5	4.254
Second period 10 to 12 weeks	17.52	2076.5	80.3	4.580
Third period 10 to 6 months	17.02	793.6	83.6	4.91
After 96 oophorin tablets	17.8	1460.1	119.9	6.712

The male dog showed a lessening of the oxygen consumption after castration (from 7.0 cubic centimeters to 6.0 cubic centimeters) but the animal lost 2 kilograms in weight offsetting this change.

The average reduction of the metabolism in the female dog for the first and second periods after the operation, that is from 3 weeks to 3½ months is about 12 per cent.

In 1899 Hugo Luthje undertook the same line of investigation, using a Volt respiration apparatus with observation periods of 20 to 24 hours. He castrated one male and one female dog at puberty and bled as controls animals of corresponding sex and born at the same birth. The male animals weighed the same and the carbon-dioxide excretion of one was 1.098 cubic centimeters and for the other 1.059 cubic centimeters per kilogram hour respectively. After the castration of one it was 0.845 cubic centimeter and for the control 0.832 cubic centimeter. The female animals were numbered 2 and 6 the former weighed 1 kilogram more than the latter. After the castration of animal No. 2, it gained slightly in weight but this was explained as not due to the deposit of fat but to the fact that it was the stronger and more robust animal. Five months after the operation No. 2 had a carbon dioxide excretion of 1.049 cubic centimeters and the control 1.056 cubic centimeters per kilogram hour. The nitrogen and phosphorus excretion in the urine also showed but slight differences with the controls.

Luthje came to the conclusion that the sex glands have no specific effect on the metabolism, and offered the suggestion that the gain in weight in women at the menopause might be due to the change in their life and habits.

The results of these last named investigators are diametrically opposed. Although their methods differed their experiments appear to be properly carried out, and it was to be expected that their results would be similar. The field for investigation might be said to be again open, for the striking and positive results obtained by Loewy and Richter in one animal can have no decisive bearing on such an important physiological problem. Zuntz suggested that the effects observed might be in the nature of an idiosyncrasy of that particular animal. As the animal was in his laboratory he fed it oophorin tablets a few years later and obtained but a 4 per cent rise in its metabolism with old tablets and a 6 per cent rise with fresh tablets as against the more than 50 per cent rise noted by Loewy and Richter.

The question is not one of scientific interest only but it is also of great practical importance. The retention of the ovary *in situ* or by transplantation in hysterectomy operations seems at present to be largely a matter of

sentiment on the part of the operator for in no way is the artificial menopause more severe than the natural as a matter of fact it is often less severe. The symptoms are advanced by a longer or shorter period and they are more apt to come to the attention of the surgeon for the patient still remains under his control. However if it should be proved that the removal of these organs deprives the body of an internal secretion having an effect on the general metabolism then their retention will become a physiological requirement.

Our work was done on two female dogs that were fed on a constant diet of meat cracker meal bone ash and lard. The metabolism was estimated by the indirect method using Murlin's constant temperature respiration incubator and weighing the oxygen entering and the carbon dioxide and water leaving the box. A sample of the residual air of the cage was also weighed at the end of each period. Especial care was given to the control of the movements of the animal. The urine was analyzed for nitrogen and the amount included in the figuring of the metabolism. The apparatus was controlled for leaks by alcohol check periods.

The normal metabolism of Dog 58 was established by a total of nine hourly observation periods made from March 21 to 28, 1917. Each day's observation was for 2 or 3 hourly periods. Between these dates the animal gained in weight 0.3 kilogram on the standard diet. The average heat production of these nine hours was 17.35 calories per hour or 2.12 calories per kilogram hour. On March 31 both the ovaries were removed and the laparotomy wound healed by first intention. The animal was able to eat a little at the evening meal on the day of operation and throughout the healing showed no ill effects. The observation periods, one on the third and the other on the tenth day had to be discarded or discontinued because of the movements of the dog licking her wound.

From the fourteenth to the thirty fifth day after castration there were four observations with a total of nine hourly periods. The average total heat production per hour was 15.3 calories a reduction of 12 per cent and the heat production per kilogram hour was 1.75 calories a reduction of 17.5 per cent. During this period the dog gained 0.7 kilogram in weight.

The second animal known as Dog 60 had had the thyroid removed the year before. She was in fine physical condition at the time of these experiments.

## DOG NO 58

Exp. No.	Date	Weight Kg	Time	Resp Exchange		R. Q.	Temp °C	Heat Production	
				CO <sub>2</sub> Liters per hr	O <sub>2</sub> Liters per hr			Total Cal. per hour	Cal. per kg. hour
7	3-4	7.85	3:09—09 09—5:09	8.5 0.87	3.58 3.75	75 70	37.5	6.3 7.66	81
8	3-5	8.60	15—00 00—	6.5 0.91	3.13 0.75	75 7	38 38	8.3 9.14	96 98
	3-17	8.5	10:30—1:30 1:30—1:30	8 0.94	3.4 3.66	84 80	36 36.7	16.43 7.43	87
10	3-26	8.5	13-1 53 13-1 5 53- 53	3.84 0.83 0.69	6.76 3.58 3.400	87 80	38 37	77 7.08 5.78	91 07 66
								Average 5	Average
11	3-31	8.46	8- 8 8-4 8	9 0.76	3.23 3.704	84	38	8.84	86 84
14	4-20	8.66	1-1 5 13-1 5	1.85 0.84	2.57 3.400	90 8	37	8.1 5.53	86 81
5	—17	8.95	02-4 03 03-4 03 04- 03	3.04 0.84 0.67	1.04 3.390 0.67	8 70 86	7	70 5.84	81 76 81
6	3-	8.80	3- 3 3- 3	1.86 0.90	0.70 3.58	86 80	38 9	4.80 16.3	66 83
								Average 14.36	Average 75

The normal metabolism was established by four observations with a total of eleven hourly periods from March 26 to April 16 1917. The average total heat production was 8.95 calories or 8.4 calories per kilogram-hour. In examining the table closely however, it would appear that the average of all the observation hours previous to the operation hardly represents the true normal or basal metabolism. The heat production on the day of the first observation is so much higher than the others that the conclusion must be reached that it is due to the stimulus of the unusual surroundings that the animal found itself in. The first period on April 4 is high because of movements of the dog and the middle period on April 5 is very high because of unexplained high residual readings for that hour. If these doubtful periods are dropped the revised average heat production is 10 calories per hour or 1.93 calories per kilogram-hour.

During these observations and preliminary to operation, the animal gained in weight a half kilogram.

Double oophorectomy was done on April 7. On the third day the skin of the abdominal wall broke open along the suture line for a distance of 5 centimeters. Two or three stitches of silk were inserted and the wound healed in the course of ten days.

From the sixteenth to the thirty-second day after castration, there were three observations with a total of six hourly periods. From the time of the operation to the end of this period the dog gained 0.6 kilogram. With the first hour not included in the calculations, because of movements of the dog,

the average total heat production was 19.81 calories or 1.64 calories per kilogram hour.

Our work with these animals had to be discontinued at this point because of the response to the call of the Government by one of the (Muffs). The animals will be kept and we hope later to transplant an ovary in one and to feed the other various glandular extracts in an attempt to affect their metabolism by this means.

## SUMMARY OF THE ANIMAL EXPERIMENTS

Regardless of the gain in weight, the metabolism of both our dogs was diminished following castration. Both animals did gain and the increase in actual amount was about the same in each, 600 grams. The diminution in the metabolism calculated on the basis of the calories per kilogram hour was more than 14 per cent in either animal (17.5 per cent in dog 58 14.2 per cent in dog 60). It is remarkable that these percentage figures should be so close together especially as the dogs differed in breed and one weighed 25 kilograms less than the other. Loewy and Richter's dog showed a reduction of 11.7 per cent in the oxygen consumption if the periods from 10 weeks to 6 months are analyzed. Curatulo and Tarulli's dog had an almost immediate and very marked reduction in its

## DOG NO 60

Exp. No.	Date	Weight Kg.	Time	Resp. Exchange		R. Q.	Temp. °C.	Heat Production	
				CO <sub>2</sub>	O <sub>2</sub>			Total Cal. per hr	Cal. per kg hr
				Liters	L. per hr.				
3-26		55	3:07-4:07	4 00	3 7	79	38	24 73	34
			4:07-5:07	3 764	4 855	78	38	3	0
			5:07-6:07	3 83	5 004	79	39	3 6	3
4-4		60	0 53-10:53	4 816	5 457	77	38 3	3 78	34
			1 53-2:53	3 780	4 726	80	38	37 45	64
3	4-3	60	1 04-1:04	3 336	4 433	80	39 7		9
			1 04-2:04	4 4	5 830	7	39 7	7 0 <sup>00</sup>	7
			05-05	3 6 6	4 994	73	39 4	2 3	
4	4-6	60	3 33-4:33	3 583	4 58	77	39 3	67	97
			3 33-4:33	3 98	4 817	76	39 3	0 01	8
			4:33-5:33	3 16	4 06	73	39 3	0 28	75
Op.	4-7							Average Revised average 0	Average Revised average 05
6	4-23	5 45	2-43-3-43	3 734	3 704	7	39 8	4 3	60
			3-43-4-43	3 09	4 190	75	39 7	9 35	
7	4-5	40	3:12-4:12	684	3 517	81	38	6 02	48
			4 3-5:3	5 70	4 6	70	38	0 04	7
8	5 0	60	4:5-5:45	3 843	4 3	8	38 3	0 55	66
			5-45-6-45	3 47	4 360	79	38 3	20 6	77
								Average Revised average 20 04	Average Revised average 7

\*Dog moved several times. \*\*High residual throws doubt on accuracy of this period.

respiratory metabolism and it gained in weight also

The argument might be used that, as the gain in weight is largely due to fat, the oxidation energy per cell unit is not greatly diminished for the fat takes an inactive part in the metabolism. However in our animals the reduction to the extent of 12 per cent in one and 6 per cent in the other remain to be considered

We noticed in our dogs that following the castration they became less active and some what more apathetic. Also as time went on they became more accustomed to us and to their confinement in the box. These factors must be considered as having a tendency to lower the metabolism. The gain in weight might be accounted for as an ordinary gain due to lessened muscular activity or as a progressive gain due to the continuance of a diet somewhat greater than their needs.

As the thyroid raises the metabolism in castrated animals, our results with dog 60 which had no thyroid acted as a control for dog 58. It was to be expected that the metabolism in dog 60 would suffer a considerably greater reduction but this was not the fact, the reverse was true for the animal with the

intact thyroid suffered a diminution in its total metabolism much greater than the other. The course of these animals would lead to the conclusion that the interactive processes that seem to exist between the thyroid and the ovary did not result after castration in an increase of the functional activity of the former in this instance at least.

Loewy and Richter mention the fact that in their dog the more marked changes occurred only after six to ten weeks and hint that the problem may be complicated for this same period elapses before the uterus atrophies after a castration.

#### METABOLISM IN WOMEN AFTER CASTRATION

That the results in animals may be transferred directly to the human subject and made the basis for therapeutic procedure is very doubtful. In 1904 Leo Zuntz feeling that too much attention had been paid to the results in the one animal of Loewy and Richter calculated the metabolism in four women who had to be castrated during the course of operative procedures necessary for their cure. All four of the women were menstruating before the operation so that it is probable that their ovaries were functionat



TABLE FROM ZUNTZ'S WORK<sup>1</sup>  
Oxygen Consumption per Kilogram per Minute

	Before Op- era	1 to 6 Weeks After com.	7 Weeks to 14 com.	After Oophor- com.
Frnk S.		6	6	4
Frnk H.		8		
Frnk K.		4	6	8
Frnk E.	5.1	8	4	4

ing in part at least. One had a tubal pregnancy one a tumor of the ovary and the remaining two had tubo-ovarian abscesses. Two of these women showed a reduced metabolism seven weeks after the operation. He explains the lessening of the oxygen consumption in the case of Mrs. S. as being within the limits of error in the experimental technique. The 20 per cent reduction in the case of Miss E. he believes due to the fact that the normal as given is incorrect because when this figure was obtained the patient was suffering from pain and fever.

After the administration of oophorin he

Zuntz, J. Geburtsh. Gynaek. 1904, 104, 254.

was unable to obtain an increase in three of the cases that received the tablets. These women did not gain in weight.

#### CONCLUSIONS

Our results uphold the work of Loewy and Richter so far as the reduction in metabolism after castration is concerned. Removal of the ovaries of our dogs was followed by an increase in weight in both and a lowering of the metabolism in one of 12 to 17 per cent, and in the other of 6 to 14 per cent.

We feel that indirect action has a bearing on this reduction and we do not believe that the indications point decisively to the loss of a specific stimulus from the ovary affecting the oxidative processes of the cells.

To throw more light on this complex subject, further experiments with animals are necessary.

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## PROGRESS IN THE STUDY OF OVARIAN TRANSPLANTATION AND OVARIAN SECRETION

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MY paper before this society two years ago comprised a report of my own work in ovarian transplantation and a review of the literature of the subject up to that time. My purpose in this paper is to bring the record down to the present time, noting what has been accomplished during this period. The study of ovarian transplantation is so intimately related to that of the internal secretion of the ovary that the material on the latter subject is also included in the present paper.

Athias (2, 3, 4) experimented in the grafting of ovaries in castrated male guinea pigs. He found that hyperplasia and secretion of the mammary gland could be brought about in this way. He describes in detail several of

his experiments. (1) Ovaries of a female adult were grafted under the skin of a young male and removed at the end of nine weeks, three days after the beginning of milk secretion. Both ovaries were intimately adherent to the surrounding tissues and no traces were left of the germinal epithelium. At the periphery was a layer of dense connective tissue to which striated muscle fibers were attached. There were numerous primary follicles normal in appearance. Below this layer there were numerous follicles in different stages of development, some normal, others undergoing atresia. Many of the follicles were quite large, containing a large cavity filled with fluid which, in the atretic ovaries, held degenerated follicular cells in suspension.

The normal ovisacs showed many cells in mitosis. The theca interna of the mature follicles and especially of those undergoing degeneration was markedly hypertrophied. In the interfollicular stroma which was very vascular there were false corpora lutea. In each ovary there was an old corpus luteum but no recent one. (2) Ovaries of a female at the end of gestation were grafted on the preceding subject after having removed the first graft and removed seven months after operation the first day of a period of secretory activity of the mammary gland. The appearance of these ovaries was very like that of the preceding ones. Primordial follicles were few but large ovisacs numerous some of them normal some atresic. In some the ovule was undergoing degeneration. The theca interna was hypertrophied especially around the large atresic ovisacs. It was made up as usual of quite large cells with siderophile cytoplasm. There were abundant false corpora lutea but no true corpus luteum old or recent. The stroma showed groups of normal interstitial cells and some degenerated cells the cytoplasm of which was loaded with pigment. (3) Ovaries of a female 15 months old grafted on a male whose mammary glands already hyperplastic and having secreted after two previous ovarian grafts began to secrete again about seven weeks after operation removed the second day of lactal secretion. The appearance of these ovaries was similar to that of the preceding ones. There were also some hemorrhagic follicles containing necrosed epithelial cells and ovarian residue. In one of the grafts there was a poorly defined mass of polyhedral cells some degenerated some quite well preserved. The cytoplasm of the latter showed siderophilia. These cells seemed to belong to a rudimentary lutein formation. False corpora lutea were abundant. (4) Ovaries of a virgin female aged about two months were grafted under the skin of a young male and removed at the end of 85 months the third day of a period of lactation. These ovaries like the others were intimately adherent to the surrounding tissues. The germinal epithelium was preserved over a considerable part of one of the grafts which

formed part of the wall of a cystic cavity it had disappeared everywhere else. Primary and developing follicles were abundant in both ovaries but the most noteworthy thing was some mature ovisacs of very large size with multistratified epithelium where there were almost no cells in chromatolysis and the ovules did not seem at all changed. There were also numerous follicles undergoing atresia the epithelium was more or less destroyed. False corpora lutea abundant no true corpora lutea. In short the ovaries of young females virgin or not grafted on castrated male guinea pigs and examined shortly after the mammary gland began to secrete were made up essentially of very abundant graafian follicles at all stages of development some normal others atresic with a very much hypertrophied theca interna and of a tolerably well developed interstitial gland lying in a connective tissue stroma which was intimately adherent to the surrounding tissues.

Athias concludes from these experiments that it is not the corpus luteum that causes the development of the mammary gland and the production of its secretory activity. In four cases of ovarian transplantation only one of the grafts had a rudimentary true corpus luteum while the others had none at all. He thinks the development of the gland structure of the mammary gland is due either to the epithelium of the mature follicles or to the interstitial gland or to both combined. In females before puberty the interstitial cells are the only cells of the ovary which show signs of glandular activity and it must be they that preside over the development of the mammary gland and the whole genital tract. At puberty and during gestation the growth of the mammary gland and its secretory development during pregnancy can only be caused if we exclude the corpus luteum by the numerous follicles which then attain considerable size and the most of which undergo retrogression and the interstitial gland which then increases considerably at the expense of the cells of the hypertrophied theca and the false corpora lutea originating in the atresic ovisacs. He thinks it is the cells which are undergoing transformation

into interstitial cells proper rather than the follicular cells which cause the growth of the acini of the mammary gland. These cells show much more of a glandular character than those of the follicular epithelium and have more intimate relations with the vessels. The development of an interstitial gland during pregnancy has been noted even in animals that do not have an interstitial gland at other times. He thinks the factors producing the growth of the mammary gland in the male guinea pig are the same as those in the normal development of the female gland though in the female secretion begins only during pregnancy.

Bentlin (6) concludes that in general the effects of ovarian transplantation are good but that the experimental results have been more brilliant than the therapeutic ones. Transplantation of small bits of ovary while it gives good results does not guarantee their permanency. The indications for transplantation have not yet been determined definitely. Hemorrhage in older individuals is better controlled by the removal of the uterus or by X-ray treatment. The most recent studies of internal secretion in the ovary he says show that pathological processes in the genital tract are very often not dependent on the ovary alone. Many diseases are affected also by the internal secretions of other organs. The chief field for transplantation is and always will be the prevention and cure of the symptoms of the menopause. Homotransplantation should be undertaken only in very young individuals and in homotransplantation it is very important that the organs should be transplanted immediately after removal from the body of the donor. He finds that organotherapy is giving progressively better results so that the symptoms of the menopause may be very much decreased in this way without the intervention of surgery.

Stocker (30) reports two cases in which he reimplanted part of an ovary. One patient was a woman of 8 and panhysterectomy was done for a gonorrhoeal condition with extensive adhesions. One of the ovaries was cut out of the excised mass and sliced into disks only 2 or 3 mm thick. An implanted

disk of this kind grows into place very rapidly as blood vessels soon grow through it. The bed into which it is implanted must be rich in blood vessels and must protect the graft from injury from without. Stocker implanted the graft in a fold in the peritoneum and the wound healed by first intention. An epinephrin test was made on the fifth day and there was no specific response as there is when the inhibiting influence of the ovaries is entirely withdrawn. The woman never had any symptom of the artificial menopause and was restored to health after five years of semi invalidism. Three years later an intestinal tumor necessitated a laparotomy. The disk of ovarian tissue was found to be about the same size as when implanted and was very vascular. Stocker did not remove a specimen for microscopic examination as he was afraid of impairing the vitality of the graft. His second case was even more successful. The ovary and tube had been removed on one side for ruptured tubal pregnancy and two years later on the other side for the same reason. At the second operation a disk of ovary was reimplanted in the same way and menstruation has continued regularly ever since and the patient's health is good.

Experimental work was done at Vets clinic in Halle (32) with a view of determining the effect of transplantation on osteomalacia. The author's name is not given. Ovaries were transplanted in 62 rabbits to determine whether osteomalacia could be produced by excessive ovarian functioning. In transplanting ovaries from one animal to a sister animal it was found that there was a considerable decrease in the calcium content of the bones. In transplanting ovaries from one animal to its mother there was a moderate decrease and in the transplantation of fetal ovaries to the mother there was no appreciable change after about three months. There was no marked change in the calcium content of the bones of the castrated animals. The conclusion drawn from the experiments is that the hyperfunction of the ovary is the most important factor in osteomalacia.

Phillips (25) reports 12 cases of ovarian transplantation. Immediately after remov-

ing the ovaries they were placed in normal saline solution at a temperature of  $100^{\circ}$  and the operation was completed. After closing the peritoneum sections were made from the most normal part of the ovary. The size of the grafts varied. In some cases a number of small pieces was used. The transplants were placed in the abdominal wall just to the side of the median incision in adipose tissue just beneath the rectus muscle. No sutures were used. This site was selected because it is easily accessible if the graft should have to be removed later and it allows of enlargement and congestion of the ovary with the least inconvenience to the patient. The ovary did not degenerate and act as a foreign body in any case though six were infectious cases and drains were used in four. In only one of the cases was the uterus removed and there is no definite information as to the patient's postoperative condition. Of the eleven other cases six are menstruating regularly every month without pain. Some of these cases had returned for a second operation on account of pain before the ovarian transplantation. There is no definite information as to the menstrual history of the other five. The immediate postoperative history did not differ from that of other laparotomy cases. In some cases there was swelling and tenderness of the grafts. In one case the graft was congested and caused considerable pain. The author believes that these patients were benefited by the ovarian transplantation and that its more general use would lessen the severity of the artificial menopause and would also lessen the number of second and third operations in gynecological disease. There is practically no risk in the operation itself. The transplant performs its function of ovulation for a number of years. If it should atrophy and cease to function at the end of this time it has at least made the artificial menopause less abrupt and enabled the patient to adjust herself to the conditions.

Norton (24) discusses Tuffier's work in ovarian grafting and says that he has under observation a number of cases of his own done within the past year. He has grafted ovaries that were almost entirely cystic, culling out

the medium sized and large cysts and implanting the residue. Some of these ovaries seemed hopelessly diseased and had been causing much pain over a long period of time.

In these cases the patients have been freed from pain and menstruation re-established by the implantation. He thinks the operation one of the most satisfactory advances in modern surgery and recommends it in diseases of the ovary. It should always be done in stead of double oophorectomy in idiots, defectives and criminals. It may also be done in those cases in which it is desirable to sterilize on account of conditions which render childbearing impossible. Except for the fact that it does not allow pregnancy it fulfills all the requirements of an ideal operation. It can be easily and quickly done. The function of the ovary both as to internal secretion and menstruation are maintained and at the same time the ovary is placed in a clean healthy bed completely protected from subsequent attacks of gonorrheal infection. With a new and diminished blood supply sclerosis and cystic degeneration are prevented or retarded. His work was solely with autotransplantation.

Newton (23) thinks transplantation of the ovary should be practiced more frequently than it has been. A small portion of the ovary conserved within the abdomen seems to retain the power of the organ as a whole. Within a year he has had half a dozen cases wherein a portion of the ovary was implanted with good physiologic and psychologic effects. He believes the internal secretion of the ovary controls menstruation. He believes the presence of ovarian tissue in old fleshy diabetic women has a controlling effect on their diabetes. In the discussion of this paper Dr Conklin said he had had good results in the immediate transplantation of small portions of ovarian tissue. He takes a small piece of normal or apparently normal ovarian tissue and places it in the pelvis or even outside the peritoneal cavity in the abdominal wall.

Nattrass (22) reports the case of a woman of 17 who came for confinement. She had suffered from hip and spinal disease for ten years. As she had a generally contracted

pelvis to such a degree that normal delivery was impossible the child was delivered by cesarean section, and on account of the patient's tubercular condition it was decided to sterilize her by transplantation of the ovaries. They were divided longitudinally and as much of the stroma cut away as possible as when the fibrous stroma is cut away the nutrient fluids permeate it more readily and more of the egg bearing part may be saved. One of the ovaries was fastened into the border of the left rectus muscle and the other close under the skin on the right external oblique. The patient nursed her baby for nearly five months and soon after nursing was stopped menstruation appeared and has continued with reasonable regularity ever since. Sometimes there is a little pain in the transplanted ovaries preceding menstruation and the ovaries swell a little. Three and one half years after operation the patient was examined. The subcutaneous graft could be felt quite easily and the patient felt a sickening sensation when it was palpated. The left ovary more deeply placed could not be definitely felt but as pressure over a certain spot produced a sickening sensation it was deemed an indication of the development of nerves in the graft. The case shows that in certain cases of double oophorectomy transplantation of ovaries obviates the artificial climacteric.

Lydston (18) gives a summary of his previous work in sex gland implantation. He believes the sex gland hormone is the most powerful cell stimulant nutrient, and regenerator known to medical science and that sex gland implantation preserves hormone production for a long time. He believes that certain physiologic and therapeutic advantages are permanent. In his cases the implanted tissue has never disappeared in less than twelve to eighteen months. Implantation may be repeated. He finds heterotransplantation practicable and has transplanted glands from the dead body if taken at any time before decomposition sets in as successfully as those from the living body. He thinks the development of senility can be retarded and longevity increased by the internal secretion from the implanted sex

glands. The climacteric may be postponed and its disagreeable features relieved. It is probable that the early stages of arteriosclerosis may be benefited by sex gland implantation and that early senile dementia may show good results. Abnormal sexual tendencies either psychic or physical, are indications for sex gland implantation. Microscopic sections of the implanted glands apparently show regeneration of the circulation and of the interstitial connective tissue which probably produces the so-called internal secretion.

Guthrie and Lee (15) report experimental work done on dogs. Two sister puppies, three months old were operated on, the ovaries of each being removed and transplanted into the other. At this time the ovaries measured about 6 mm. in length. The animals were operated on simultaneously. The ovary was instantly transferred to the other animal and fastened to the pedicle of the former ovary by means of a thread previously inserted into its base. The animals made uneventful recoveries. One was lost, the other killed by accident eighteen months after operation. The right ovary appeared normal and much larger than at the time of transplantation. The left ovary was represented by a cystlike mass the size of a navy bean dark in color and soft to touch. When the capsule which was markedly thickened, was opened a small gelatinous mass was found. Histologic examination of the right ovary showed abundant normal histologic elements including corpora lutea. The left ovary had undergone complete colloidal degeneration at least so far as the reproductive elements were concerned. As no attempt at mating the animal was made the experiment is not conclusive as to the possibility of pregnancy. But from the result the authors believe that ovarian transplantation in dogs is not only feasible but offers promising means of obtaining information as to optimum conditions for successful transplantation and also information as to heredity.

Graves (14) transplanted ovarian tissue in 69 cases in most of them for the purpose of preventing ablation symptoms. In 19 earlier cases the transplantation was made into the broad ligaments. In these the ablation

symptoms were found to be worse as regards severity than when the ovaries were entirely removed. Vicarious menstruation occurred in one and cystic enlargement with tenderness of the transplanted piece of ovary occurred in three. In the remaining cases the transplantation was made into the abdominal wall. In 23 cases from which reliable data were received the ablation symptoms were almost identical with those in completely castrated women. He has had better results in treating ablation symptoms with ovarian extract and his results were better with extract of the whole ovary than with that of the corpus luteum alone. He thinks there is certainly an ovarian secretion that is not produced in the corpus luteum for profound effects are produced by removal of the ovaries before puberty when there are no corpora lutea. He does not know whether this early secretion originates in the follicles or the highly differentiated connective tissue of the ovarian stroma. Other conditions in which ovarian extract has been found of service are kraurosis and functional amenorrhœa in the young. The cause of the vasomotor disturbances following removal of the ovaries the author thinks may be due to the influence of some other organ of internal secretion which has been rendered abnormally active by the loss of the balancing power exerted by the ovarian secretion. It is conceivable that the thyroid is made overactive by the removal of the ovaries and that ablation symptoms are manifestations of hyperthyroidism.

DeLee (11) describes two cases of autotransplantation of the corpus luteum done with the hope of preserving pregnancy. Both were cases of pregnancy at about the eighth week complicated by ovarian cyst which necessitated operation. Both cases failed in this object, but they proved that it is a safe procedure surgically to embed corpus luteum in the broad ligament. When DeLee again performs the operation it is his intention to give extract of corpus luteum by mouth. In neither case was the implanted corpus luteum palpable in the broad ligament at the later operation (curettage necessitated by hæmorrhage) but it is to be expected from

the constitution of the corpus luteum that it would be rapidly absorbed.

Manley and Marine (20) performed 9 autotransplantations of ovarian tissue into the subcutaneous tissue of the abdomen after removal of both ovaries. In all cases the stroma, interstitial cells and graafian follicles showed survival and growth over periods varying from 34 to 219 days. Mature graafian follicles were recovered from two rabbits associated with active hyperemia of the uterus and typical phenomena of rut. In some of the older transplants there were hæmorrhagic cysts due to the fact that the ripened follicles rupture into themselves instead of onto a free surface as normally and these cysts finally produce pressure atrophy of the ovarian tissue. Apart from this complication the work of these authors confirms that of many other investigators that autotransplants are permanent and show functional activity. They also made 26 homotransplantations of sexually mature ovarian tissue all but one of which were completely absorbed except for the interstitial and luteal cells. This one instance was probably a failure of the host to react in the usual way to the graft. The fact that the lipid cells of the ovary can survive upwards of 193 days while the stroma and egg cells undergo absorption in a few weeks shows that the lipid-containing tissue exhibits a different order of cells against which the host reacts very slowly if at all. Repeated homotransplantations into the same animal of these lipid-containing cells of the ovary would probably determine whether or not the host eventually develops a resistance to this tissue also. Up to the present the authors have not made sufficient experiments to determine this point. The two important facts observed in the homotransplantation of ovaries are (1) the host reacts in the usual way and the usual time to the egg and stroma cells and (2) the host reacts very feebly to the lipid-containing cells.

In their work in transplanting the thyroid they found that the rate of absorption could be modified by modifying the condition of the host and also by modifying the chemistry and physiologic activity of the thyroid used. They found that when iodized thyroid was

engrafted into iodized rabbits the rate of destruction was markedly decreased. As iodine is a physiologic constituent of thyroid and as these experiments show that its previous administration to both donor and host delays the *rapidity of absorption of homografts* it seems certain that it is possible to modify the usual reaction of the host by strictly physiologic means. While iodine favorably affects the thyroid there is no evidence that it has a similar action on other homografted tissues but it suggests that it may be possible to modify the host's reaction to other *homografted tissues* through one or more of their specific chemical constituents. The future of tissue transplantation as a therapeutic measure rests on a solution of the problem of the homograft.

In the discussion of this paper Dr. Robt. T. Morris stated that in trying to make rabbits immune to each other's serum he found that apparently these rabbits absorbed the grafts more readily than rabbits not so treated. This shows that the problem is one for serologists. Undoubtedly in making transplants we shall sometimes sensitize. In some cases in which we produce allergic phenomena without transplants we shall be enabled to work out further treatment on the basis of the degree and effect of the allergic response.

Bell (5) worked with rabbits and dogs and found that if the ovaries be excised and implanted in the muscle of the uterus or abdominal wall atrophy of the genital ducts will not occur. He found that the follicles first become cystic and then degenerate—that is to say they ripen but if completely buried cannot expel the contents and therefore become cystic and retrogress. He also noted that in the rabbit if only the central portion of the ovary which contains no follicles be implanted the interstitial cells of which the graft is composed can maintain the integrity of the uterus alone. It is probable that ovarian transplantation in general and of the interstitial cells in particular are capable of keeping normal the uterus, the mammae, the other endocrine organs and the general metabolism in the female animal. And, since the isolated interstitial cells are effective in this respect it is probable that the follicular

secretion has no function beyond nourishing the ovum and influencing the dehiscence of the follicle—at any rate in the rabbit. In Bell's experience ovarian transplantation in women has not been so certainly successful as in the lower animals. The best results have been obtained in rabbits in which the interstitial cells are very well developed. He concludes that it is not the ovaries alone which influence the female characteristics and genital functions except in regard to the production of ova. The ovaries are only a part of a system to which most, if not all, the other endocrine glands belong and in which these other organs figure with as great importance as the ovaries themselves.

Abderhalden (1) says that no definite basis can be established for study of the internal secretions until the active principle of each gland has been isolated and its effects determined. With a view to furthering this end he took the various glands of internal secretion digested them with ferments and tested the resultant solutions by placing tadpoles in them and noting the changes produced in their growth and development. The results with ovary were not uniform due probably to the fact that ovaries at different stages of development were used. In general the ovary animals showed hastened development with a tendency to the development of abnormal forms. There was a certain resemblance to the thyroid animals. In animals acted on by combined ovary and thymus the effect of the thymus was dominant.

Stettner (29) working along the same lines fed tadpoles with beef thymus tissue, genital gland tissue and thyroid, separately or in various combinations. Most of the glands of internal secretion seemed to have a retarding action on the development of the tadpoles delaying the metamorphosis into frogs. Thyroid tissue alone seemed to have the opposite effect. While thymus and genital gland tissue separately each retarded metamorphosis when they were given together the tadpole developed normally. This would seem to indicate that the thymus and genital glands supplement each other their combined action being necessary for normal growth.

Taniguchi (31) describes in detail experiments with corpora lutea of cows and with ovaries freed from corpora lutea. The corpus luteum contained a ferment which split yeast nucleic acid forming phosphoric acid and purin bases also an erepsin like ferment an abundant amount of amylase urease an asparagin splitting ferment, a ferment resembling trypsin, a butyl ether splitting ferment, a small amount of salicin splitting ferment arginase and a slight amount of an amygdalin splitting ferment. It did not contain a glycocoll splitting ferment lipase leathinase invertase lactase or glycolytic ferment. The ovaries free from corpus luteum contained the same ferments and were lacking in the same ones.

Serono and Palozzi (28) examined cows ovaries and found that they contained practically the same percentage of lipoids as egg yolk and of practically the same composition so there is no specific function of the ovaries due to the lipoids. The action of the ovary is due to its internal secretion and the authors in a previous article<sup>1</sup> have shown that it is very rich in ferments.

Goodale (13) found that if the ovaries of a domestic fowl be removed many of the secondary sexual characters of the male appear. He considers the question of whether the secretion is a modifier or an inhibitor. If it is a modifier there is only one genetic basis that responsible for the male secondary characters and the modifier changes male into female characters. Inhibition requires two genetic bases one for male and one for female characters. In the absence of ovarian secretion male characters appear. If the secretion is present it inhibits male characters and allows female characters to appear.

Blanchard (7) found that feminine characteristics are produced in males by loss or atrophy of the testicles and conversely male characteristics in the female by removal or functional deficiency of the ovaries. He has noted the frequency of masculinity in insane alien females most often involutional forms of mania. It is not improbable that a change in the ovarian secretion in the female produces masculinity and mental disturbance.

Bainbridge (8) while admitting that the definite information as to the rôle of the internal secretion of the ovary in the mammalian economy is slight concludes that autotransplantation of healthy ovarian tissue is feasible and that it is advisable in certain cases. Whether it does or does not preserve the generative function it seems to tide the patient over from normal ovarian function to the menopause with less discomfort. He believes that in the reported successful cases of heteroplastic ovarian transplantation it is possible that a minute part of functioning ovary was left in the body which caused the succeeding pregnancy rather than the grafted heteroplastic ovary. In his opinion, neither organotherapy nor ovarian transplantation have as yet succeeded in nullifying the necessity for conservative surgery of the uterus and ovaries.

Bucura (9) thinks the corpus luteum alone cannot be the source of the internal secretion of the ovary as the hormone action is manifest in the child and in the newborn before the corpus luteum has developed. He believes the follicle is the source of the internal secretion but the corpus luteum is the only internal secreting part of the follicle remaining after the expulsion of the egg and it hypertrophies and perhaps performs the function potentially. Therefore the corpus luteum action is not a specific one but only a quantitatively increased follicle action. So long as the follicle in the child's ovary produces the hormone it is a constant quantity but a minute one favoring only the gradual development of the sexual characteristics of the child. The stronger development of the follicle at puberty is accompanied by stronger hormone development and with it more rapid development of the genitalia and sexual characteristics. The important thing at puberty and sexual maturity is the increased hormone production not the corpus luteum.

Herrmann (17) describes in detail his method of obtaining the active principle of the ovary and placenta in pure form. His ovary extract is purely a corpus luteum substance. When pure it had no bad effect on animals when used experimentally. It had a powerful effect in stimulating the growth



and development of the sexual organs. After five days injections young animals eight weeks old showed the sexual development of animals twenty five to thirty weeks old. When the injections were continued changes took place similar to those of the rutting period or of early pregnancy. The mammary glands of both male and female animals developed rapidly. The extract also contributed to the development of the secondary sexual characters. The same substance was found in the corpus luteum and the placenta.

Piccione (26) performed experiments with rabbits. He found that on removing the ovaries *anemia ensued from which he concludes that the internal secretion of the ovary has a physiological effect on the composition of the blood.* This effect consists in a direct stimulation of the organs that produce the red and white cells favoring the formation of hemoglobin and increasing the resistance of the red cells. Feeding ovarian extract to these animals improved the condition of their blood.

Russo and Monterosso (27) gave rabbits subcutaneous injections of lecithin 44 in the course of 11 months. They describe the histological appearance of the parietal cells of the ovarian follicles from which they conclude that the parietal cells of the ovarian follicles of the rabbit normally have a function of internal secretion secreting a product that goes to nourish the ovum through the medium of the liquor folliculi, or through the mechanism of the follicular epithelium which represents a classical circulatory system, adapted for carrying to the ovum nutritive materials either those arriving through the blood stream, or those elaborated locally.

Mitchell (21) conceived the idea that the injection of peptone might inhibit the antagonistic action of the host against engrafted tissue. Carrel found that limbs engrafted on an infected host were more apt to live than those on an uninfected one so it would seem that the infecting bacteria had some inhibitory effect on the action of the host against the graft. Besredka, Stroebel and Jupille have shown that the action of complement on bacteria gives a substance identical in many

of its physiological properties with the substance obtained by the action of complement and peptone so it seemed reasonable to suppose that the injection of Witte's peptone would have a similar effect on the reaction of the body against engrafted tissues. To test this he transplanted ovaries in rabbits. The rabbits were operated on in pairs so as to get immediate transfer of the grafts. Peptone injections were made at the time of operation and every four days afterward till the animals were killed. The rabbits used as controls were operated upon in the same way but given no peptone. Following the peptone injections the animals showed labored breathing, restlessness and general bodily weakness similar to that described as following injection of an attenuated dose of peptotoxin which had been formed by the reaction of complement and peptone outside the body. After three to four injections the animals showed reduced metabolism evidenced by loss of body weight and marked thinning of coat. This was not noticed in the controls which were not given peptone but were otherwise treated in precisely the same manner. As a result of his experiments Mitchell reached the following conclusions: (1) Peptone injections as they were made tend to intensify rather than to inhibit the action of the host against homogeneous grafts of ovarian tissue. (2) Such injections of peptone produce a condition of reduced metabolism in the animal but not to such an extent as to endanger life. (3) An abundant blood supply to the graft does not indicate that it is viable in its new environment but may rather be evidence of an intense reaction against it on the part of the host. (4) The destruction of the graft is practically complete by the end of the sixth week in both the animals injected with peptone and in the controls. (5) The host primarily reacts to the presence of the graft by revascularization of its tissues and the further reaction which evidently involves the destruction of the graft, is evidenced by round cell infiltration and proliferation of the connective tissue of the host.

#### CONCLUSIONS

The review of the literature for the past two years serves to confirm the conclusions

arrived at two years ago namely that so far the only form of ovarian transplantation that is practicable is autotransplantation and that this has a rather limited field of usefulness in the retardation and modification of the symptoms of the artificial menopause brought about by complete removal of the ovaries. In spite of the perhaps overenthusiastic conclusions of a few workers neither homo- nor heterotransplantation has as yet justified its use in human surgery. The great problem yet remaining to be solved in ovarian transplantation is to find some means of overcoming the resistance of the body to homografts for this is the only means of opening up a wide field of usefulness for the operation. The way to a solution of the problem lies through a closer study of the internal secretion not only of the ovary itself but of the other glands of internal secretion, all of which seem to be so closely interrelated that absolute separation of their functions seems impossible. Some hopeful work has been done in endeavoring to find substances which will inhibit the resistance of the host to the graft, but for the most part the work still remains to be done and the surgeon in adopting ovarian grafting instead of solving a problem has rather opened up a greater one which awaits solution by the serologist and endocrinologist.

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## THE AUTONOMIC SYSTEM AS AN INTEGRATOR WITH SPECIAL REFERENCE TO THE UROGENITAL ORGANS

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**E**QUILIBRIUM of function represents a dynamic state resulting from the antagonistic chemical and physical forces which combine to make up its sum total. Quantitatively it may be conceived as the arithmetical mean of the positive (excitant or stimulative) and negative (inhibitive) processes, and the dynamic equilibrium shifts in one direction, as the positive factors increase or the negative decrease or in the other as the negative factors increase or the positive factors decrease. Such a dynamic state forms an extremely flexible and labile system easily disturbed and efficiently sensitive to environmental changes.

In the body functional balance is brought about by the interplay of two general mechanisms which make their appearance phylogenetically at different stages in development. The first and older of the two is chemical correlation by means of which the various parts of the organism become integrated by means of hormones.

In the lower forms of animals adaptation to environment is automatic. Just as in physical systems, disturbances tend to bring about reactions of a nature to minimize the change in equilibrium, so in more complex organisms stimuli excite reactions whose purpose is to restore the system to its original physiological state. This automatic self-preservative mechanism in its simplest form is fulfilled by the laws of diffusion, osmosis, and surface tension as applied to living matter and serves as the prototype of the more complex mechanism as it is found at present in the chemical correlation of the endocrine glands. This latter arrangement represents

an equilibrating mechanism of considerable delicacy but presenting a sluggishness of reaction and lack of rapidity of consummation which acted as a considerable disadvantage to the organism. The second coordinating mechanism consists of the nervous system brought in being as a more rapid and hence more effective means whereby the body may advantageously be adapted to its environment.

Although these two great correlating systems are in a sense independent from the viewpoint of their place in the living organism, nevertheless they are distinctly interreacting, and of late considerable attention has been paid to the effect which the hormones exert upon the nervous system, particularly the autonomic or vegetative (involuntary) division. Such a relationship best shows itself in the effect produced by adrenalin or epinephrin on the thoracico-lumbar autonomic or sympathetic nervous system. There is much evidence however for the notion that this interdependence of the nervous system and the endocrine organs is exerted in both directions; not only do these glands form hormones which influence the reaction of the nervous impulses upon the effector organs, but conversely the condition of the autonomic nervous system affects the impulses delivered to the endocrine organs, and thus regulates their activity, and hence their share in the dynamic equilibrium in which they play a part.

Therefore if the autonomic or vegetative division of the nervous system supplies innervation and controls in part the glands of internal secretion it is fitting that this division of the general nervous system be considered

from the standpoint of its derivation and general structure before the method and degree of supervision takes up our attention.

The most primitive type of interacting nerve pathways existed as a nervous net or plexus like those found in the coelenterates. In this system primitive sense cells were brought into diffuse relation with primitive muscle cells for the benefit of the whole organism. Rapid but diffuse transmission stands as the chief characteristic of such a mechanism of interrelation of the component parts of the organic unit. As development proceeded there occurred *pari passu* a differentiation of the nervous elements. Certain sense cells developed more special and localized connection with the central organ and the center thus created assumed additional control over the relation existing between the sense cells (receptor surfaces) and the muscle cells (effector organs). Thus became evolved the neural architecture for the most primitive reflex—a specific and direct rather than diffuse relation between receptor surface and effector organs. The final stage of neural evolution is seen where as the result of adaptation the projicent sense center became developed in the anterior portion of the nervous system for reasons easily conceived. Distance receptor surfaces adapted to receive impressions of wave motion, sound and light, or particles transmitted by the air were located at the anterior surfaces of the body. These were eventually resolved into the brain and became connected necessarily with the motive power of the body, namely the muscles. Conscious control over movement through the cortex, cord and peripheral nerves and voluntary muscles gave the last touch to the present efficient nervous system of the higher mammals.

According to one point of view there exists as a part of the present nervous system of man a complex descendant of the primitive net or plexus of the lower animals, the autonomic system which retains its original function of automatic reactivity and relatively at least independent of the central nervous system which maintains voluntary control. As development proceeded this typical primitive net upon which the animal

depended entirely for its adaptation became connected with the cord and from thence the brain of the mammal.

The autonomic or sympathetic nervous system received its first careful consideration by Langley (2) who correctly conceived its significance and its broad interrelation with the central nervous system. In general the system is composed of fairly well localized groups of cells or ganglia situated in various parts of the body designated as the sympathetic chain or vertebral ganglia lying on each side of vertebral column, the *prevertebral* or *collateral* ganglia such as the celiac, inferior and superior mesenteric, and the *peripheral* or *terminal* ganglia, the otic, sphenopalatine, submaxillary, ciliary, etc. the latter linked together by plexus. All these ganglia are connected with the central nervous system by nerve pathways whose fibers have their cells of origin in the midbrain, medulla or cord.

The autonomic nervous system is fashioned upon the structure of a reflex mechanism whose *effluent* (motor) arc therefore functions as a carrier of impulses originating reflexly and involuntarily in the cord or perhaps higher centers and bringing about reactions in involuntary (non-striated) muscle (walls of the blood-vessels, viscera, heart, etc.) and glands (salivary, peptic, pancreatic, etc.) of the body. The diffuse centers of such reflex arcs are played upon by impulses having their inception in all parts of the body and conveyed by *afferent* fibers both somatic and visceral (sensory neurones of the posterior root ganglion). Dogiel assumes also that afferent autonomic neurones exist with cell bodies in the autonomic ganglia whose purpose consists in conducting impulses from the viscera to the cells of the posterior root ganglia. Unfortunately little is known of the intimate structure of this portion of the autonomic reflex arc. The usual conception of the autonomic system includes only the efferent or motor portion of the mechanism.

This efferent system of nerves is composed of chains of neurones containing at least two cells. The first cell in the chain has its cell body in the central nervous system; its axon is medullated and is called the *preganglionic*

fiber. The terminals of this neuron arborize around cells situated in the various autonomic ganglia; the name *postganglionic* has been given to these latter ganglionic cells with their axon fibers. The synapse between the preganglionic and the postganglionic cells existing in the ganglion is the great feature distinguishing this peripheral system from the cerebrospinal outflow. The pathway of the latter consists of a single cell whose body resides in the anterior horn of the gray matter of the cord and whose axon passes out as the anterior root to end in the effector organ. In the autonomic system however one preganglionic fiber also originating in the central nervous system comes in contact in the ganglion by its terminal arborizations with the dendrites from several postganglionic neurones thus allowing a spread of impulses to occur. In such a sense an autonomic center exists but reflexes as are commonly mediated in the centers of the brain or cord never take place over these autonomic synapses.

The whole system is divided according to the general position of origin and exit of the preganglionic neurone from the midbrain, medulla and spinal cord. The purpose of the preganglionic neurone is to link the central nervous system to the true autonomic nerve cells in the ganglia.

The *preganglionic fibers* leave the midbrain and medulla via certain of the cranial nerves but from the region of the cord they pass out with the anterior root fibers, and become the white ramus for each spinal segment between the first or second dorsal and the third sacral nerves. They are divided as follows: (a) Those cells which reside in the nuclei of origin of the third, seventh, ninth, tenth, and eleventh cranial nerves and terminate in the corresponding ganglia on the trunks of these nerves; they are called the *cranio-bulbo autonomic system*. (b) Those whose cell bodies are found in the intermediolateral tract of the cord and whose axon passes out of the cord via the anterior roots (second dorsal to third lumbar inclusive); these are designat-

ed as the *cervico-thoraco-lumbar autonomic*. Some of these axons pass headward to end in the stellate inferior and superior cervical ganglia. This pathway received the name of the cervical sympathetic. Others terminating in the sympathetic chain ganglia, the coeliac inferior and superior mesenteric ganglia, and perhaps in some of the associated plexus, e.g. hypogastric, renal, aortic, etc. are designated as abdominal sympathetics or splanchnics. (c) Those whose axons pass out over the anterior roots of the second and third sacral nerves. This outflow differs from the thoraco-lumbar in that whereas the latter passes into well-defined ganglia which give rise to postganglionic fibers that travel some distance before reaching their effector organ, the former pass directly into a nerve plexus, e.g. vesical, hypogastric, prostatic, utero-vaginalis, etc. throughout which are scattered the postganglionic cells. In most instances, these are in close proximity to the effector organ. The functional significance of this difference will be discussed later. These are called the *sacral autonomic* and form the pelvic nerve.

The *postganglionic fibers* of the cranio-bulbo autonomic originate in the ganglia on the trunks of the corresponding cranial nerves, e.g. third, fifth, seventh, sphenopalatine and submaxillary, ninth, tenth, jugular and nodosum. Those of the cervico-thoraco-lumbar division which have their cells of origin in the vertebral chain ganglia take two general directions. Some leave the vertebral ganglion and pass as gray rami back to the spinal nerves which they join. These fibers which are non-medullated follow the segmental nerves to their ultimate distribution and supply vasomotor, pilomotor or sweat impulses to the corresponding effector organs. The other postganglionic fibers of this division traverse the space between their original ganglion whether it be one of the prevertebral or peripheral ganglia and terminate in the effector organ in direct relationship with the cells of the organ or tissue.

One exception and an important one exists to this general description. The autonomic supply to the suprarenals is carried

Based upon the more general view that there does not exist physical continuity between neurones, the term synapse represents the space between the terminal arborizations of one neurone and the dendrites of its contiguous neighbor.

via the thoracico-lumbar or sympathetic outflow. In this case the preganglionic fibers pass through the vertebral chain and the coeliac plexus and end in immediate connection with the chromaffin cells of the medulla. Since in ontogenetic and phylogenetic development the chromaffin cells are closely related to those cells which are to form the postganglionic neurones (3) it is assumed that these chromaffin cells have wandered to the locus of the cortex of the adrenal or interrenal body have become fused with it, and represent therefore postganglionic cells the specific function of which is the formation of a hormone epinephrin of extreme significance for the integrity and activity of the thoracico lumbar autonomic fibers.

The postganglionic cells of the sacral autonomic lie in the plexus situated on or near the organs or tissues which they innervate.

Following Langley therefore the autonomic efferent system is divided into the cranio-bulbar cervico-thoracico lumbar and sacral divisions according to the region of outflow of the preganglionic fiber from the central nervous system.

It may not be amiss to pause a moment to mention the unfortunate conflict in terminology which exists in describing the various parts of this system. The cause for this lies in the various conceptions which are attached to the function of the system as a whole and of its integrating divisions.

The following scheme will indicate the corresponding terms usually attached to the various subdivisions of the autonomic system. Throughout this paper the Langley nomenclature will be employed it is to be found in parentheses in the table. Where the term sympathetic is used it will apply solely to the cervico-thoracico-lumbar division of the autonomic system.

	Langley	
Autonomic system (Efferent autonomic)	Preganglionic	{ Cranio-bulbar, cervico-thoracico-lumbar sacral
	Postganglionic according to ganglion	{ Chain, lateral or vertebral, collateral or pre-vertebral, peripheral
	Common (English)	
Autonomic system	{ Parasympathetic (Cranio-bulbo-sacral)	
	{ Sympathetic (Cervico-thoracico-lumbar)	

	Eppinger and Hess (German)	
Vegetativ system	{ A. tonomic (Cranio-bulbo-sacral)	
	{ Sympathetic (Cervico-thoracico-lumbar)	
	Gaskell	
Involuntary nervous system	{ Cranio-bulbar	
Connector (Preganglionic)	{ Cervico-thoracico-lumbar	
	{ Sacral	
Sympathetic system (Post ganglionic)		

	Ranson	
Systema nervosum sympatheticon		
Autonomic components	{ Cranio-sacral	
	{ Thoracico-lumbar	
Extrem components	{ Plexus of Auerbach and Meissner	

	Herrick	
Sympathetic nervous system	{ Cerebro-spinal visceral (Preganglionic)	
Efferent neurones	{ Peripheral autonomic (Postganglionic)	

## FUNCTIONAL RELATION OF THIS SYSTEM TO THE CENTRAL NERVOUS SYSTEM

The autonomic system is sometimes termed involuntary under the assumption that the effector organs (non striated muscle glands etc.) supplied by it are not under control of the will in contradistinction to the volitional relation which exists between the cortex and the striated muscles. This distinction is not a hard and fast one as striated muscle is sometimes not under voluntary control. This is true of the cremaster muscle and the muscles of the pharynx on the other hand voluntary stoppage of micturition is supposed to be brought about by control over the non striated muscle of the sphincter of the urinary bladder.

However a certain independence of the central nervous system does exist and in general the system may be said to be removed from voluntary control nevertheless it is distinctly influenced by affective states whose site of origin must be considered to be in the cortex or in subcortical nuclei. Thus joy produces a rapid heart, shame blushing, fear pallor, odors vomiting, sexual excitement, erection all these changes are dependent upon a disturbance of equilibrium effective through the autonomic system. Certain cases are reported of so-called voluntary control over autonomic reactions e.g. power to change the rate of heart to produce goose flesh, to dilate the pupils etc. An examination of these individuals discloses the fact however that these reactions are brought into being by the *voluntary* production in consciousness of the proper emotion or affective state.

which acts as the immediate cause for the bodily change

Cannoo (4) has likewise shown that such emotional states as pain, produce bodily changes of a distinctly adaptive nature, all tending to provide an effective means of offense against the agent or stimulus producing the disadvantageous environment. Thus the decrease in activity of the processes in the alimentary canal the shunting of blood from the viscera and skin to the muscles heart, lungs and central nervous system by vaso-dilatation in the latter organs the rapid abolition of the effect of muscular fatigue, the shortening of the coagulation time of the blood the increase to the sugar content of the blood all of these phenomena are immediately serviceable in producing a more effectively reacting mechanism along the lines of a sufficient mobilization of energy in order that the proper reaction of the organism to the immediate source of the emotion may become efficiently possible. By way of an example injury to the surface of the body results in the emotional state of pain. The functional changes in the body which follow may be considered as purposeful in this way, the shortening of the coagulation time of the blood suffices to insure a rapid stoppage of loss of circulatory fluid by hemorrhage the redistribution of the blood supply from the surface of the body and viscera to the muscles allows of an increase flow to the latter organs without decreasing the blood pressure. The hyperglycemia offers to the muscle a greater supply of energy for excessive contraction the decrease in the fatigue producing power of the muscle establishes the ability of the body to perform exaggerated and continuous muscular contraction which teleologically would be explained through the reflex desire of the organism to remove it self rapidly from the source of the disturbance i.e. the pain producing agent. Thus the emotions set at liberty energy which allows the excessive demands on the neuromuscular system to be fully coped with.

Under normal conditions the efferent neurones (preganglionic cells) in the central nervous system are discharged from afferent neurones in a way similar to the produc-

tion of any reflex of the neuromuscular mechanism through the cerebrospinal nerves. Thus the presence of food in the stomach reflexly through afferent visceral fibers brings about a gastric vasodilation and a consequent cerebral anæmia mediated through the vasomotor center in the medulla and the vasomotor autonomies of the splanchnic area.

#### INTERACTION OF THE INTEGRAL DIVISIONS OF THE SYSTEM

The integral parts of the autonomic system possess peculiar characteristic relations one to another. In obtaining the balanced mechanisms upon which is dependent the state of equilibrium that we find in many of the visceral muscles the autonomic furnishes the antagonistic forces. In general it may be stated that whenever the middle portion of the autonomic outflow (sympathetic or cervico-thoracico-lumbar) meets either of the extreme divisions of the system (bulbo-cranial and sacral) in a dual nerve supply to any organ or tissue the effect of the two are antagonistic. The accompanying chart (Dual Innervation) will show this readily

DUAL INNERVATION		
Cranial autonomic Pretectal—3rd nerve Heart—Vagus Cervico-lumbar Splanchnic nerve—4th nerve	Myocardium Bradycardia Increased peristalsis (Splanchnic) Salivation	Cervical sympathetic Myocardium Tachycardia Decreased peristalsis Atonic constriction Dry mouth (Cervicotomy) Chloric to pupil
Sacral nerve		

#### RECIPROCAL INNERVATION IN THE AUTONOMIC

If we recall the mechanism of reciprocal innervation as applied by Sherrington (5) to the movements of the appendages by which to produce flexion, the flexors contract and the extensors undergo corresponding inhibition. It becomes evident that the above dual innervation with its consequent antagonistic effects offers a similar reciprocally acting mechanism in the autonomic system. If the cervical sympathetic (cervico-thoracico-lumbar) is severed and therefore incapable of bringing about a dilation of the pupil, the pupil nevertheless will dilate in a paroxysm of anger. This can only indicate that central inhibition of the sphincter which usually accompanies the stimulation of the dilators

is now effective alone. Reciprocal innervation is also shown by the nerve cells present in the ganglia of the vagus and pelvic nerves and the inferior and superior mesenteric ganglia. The following table will show this.

#### RECIPROCAL INNERVATION

BULBO-SACRAL VAGUS	THORACO-LUMBAR OR SYMPATHETIC
<i>Mechanism to allow of emptying the intestine</i> Cells in plexus of small intestine supply Motors to small intestine Inhibitors to ileocecal and pyloric (?) sphincter.	<i>Mechanism to allow of filling of the intestine.</i> Cells in superior mesenteric ganglion supply Inhibitors to small intestine. Motors for ileocecal and pyloric sphincters(?)
<i>Pelvic Nerve</i> <i>Mechanism to allow of emptying intestine and urinary bladder</i> Cells in caecal and rectal plexus supply Inhibitors of sphincters (vesical and inferior acon.) Motors to bladder and large intestine	<i>Mechanism to allow of filling the intestine and urinary bladder.</i> Cells in inferior mesenteric ganglion supply Motors for sphincters (vesical and inferior acon.) Inhibitors to bladder and large intestine.

This table emphasizes that not only is there an antagonism in reciprocal innervation between the bulbosacral and the thoracico-lumbar division of the autonomic but also in each division a mechanism for motor and inhibitory supply is provided to facilitate certain visceral functions.

Certain differences exist between the sympathetic (cervico-thoracico-lumbar) outflow and the cranial and the sacral autonomies. The extensiveness of the peripheral innervation of a nerve trunk is determined by the opportunity that exists for the spreading of the impulses along the pathway through synaptic connections in the ganglia and the nearness of the distributing centers to the effector organs. In the case of the cervico-thoracico-lumbar the ganglia e.g. coeliac, are at some distance from their periphery and contain cells (postganglionic) which supply organs over an extensive domain impulses coming into these ganglia over preganglionic fiber undergo therefore considerable spreading and as a result diffuse reaction occurs in portions of the sympathetic even though only a relatively restricted segmental outflow from the cord has occurred. It is different with the cranial and with the sacral portions of the autonomic outflow. Here the postganglionic cells originate in ganglia which lie in close proximity to the effector organ e.g. ciliary outflow pelvic vesical plexus etc. These di-

visions possess therefore only restricted innervation

#### AUTONOMIC INNERVATION OF THE UROGENITAL APPARATUS

The urinary bladder receives innervation from two divisions of the autonomic outflow (a) the thoracico-lumbar (abdominal sympathetic) and (b) the sacral. As previously stated these two pathways carry impulses which produce antagonistic effects. The main mass of preganglionic fibers of the sympathetic outflow pass out via the second and fifth lumbar spinal segments as white rami and end in the inferior mesenteric ganglion but some axon branches may extend forward in the hypogastric nerve and terminate in the vesical plexus on the walls of the bladder itself. Postganglionic fibers originate in the inferior mesenteric ganglion and continue as the hypogastric nerve to the vesical plexus and thence to the bladder musculature in the case of preganglionic neurones terminating in the peripheral plexus their postganglionic cells are found here. The axons of the latter are short and end also in the bladder musculature. This possible arrangement forms the anatomic basis for the following axon reflex (6). Stimulation of the peripheral end of one severed hypogastric has long been known to effect a contraction of the unstriated muscle of the vesical wall on the other side and this phenomenon persists even though all connections with the cord are discontinued. This reflex results from impulses originating in a preganglionic fiber carried in the hypogastric of one side and passing cerebralward to a collateral axon which supplies the other side of the bladder. The impulse now spreads caudalward over the collateral branch to its termination at which point it sets into activity the postganglionic fiber in the inferior mesenteric ganglia. This discharges along its pathway which ends in the bladder musculature of the other side. A reflex consequently occurs through the branching axon of the preganglionic fiber and not over a synapsis as is the case in reflexes in the cerebrospinal system. Hyperæmia in a portion of the surface of the body consequent upon irritation



of the skin by substances such as mustard is also to be explained by axon reflexes.

It has been shown however by Elliott (7) that the extent of the vesical reflex differs in various animals in the monkey it is confined to the neck and base roughly the triangular area called the trigonum. This is of significance since it indicates that the sympathetic motor control of the bladder concerns the musculature of the sphincter region.

The discovery of Dale (8) that ergotoxin paralyzes only the motor fibers of the sympathetic system made possible the detection of inhibitory pathways previously unexpected. Adrenalin brings about reactions in the body either motor or inhibitor which simulate those initiated by the cervico-thoraco-lumbar outflow. If this system supplied motor and inhibitor fibers to the same organ it became difficult to disentangle the effects. If ergotoxin, however, is injected into the animal the motor endings are paralyzed and the effects removed. Inhibition now comes into prominence. In this way it has been shown that the sympathetic carries inhibitor fibers to the walls of the bladder. It is evident therefore that both the motor cells to the sphincter (trigonal area) and inhibitory cells of the main musculature of the bladder wall are to be found in the same ganglion (i.e. inferior mesenteric ganglion (see table Reciprocal Innervation)).

The sacral autonomic supply leaves the cord with the second and third sacral nerves as white rami and forms the pelvic nerve (preganglionic fibers) on each side. Each nerve divides into an anterior and a posterior division, the latter connecting with the rectal plexus from which arise motor fibers to the large intestine while the former carries fibers to the vesical plexus in which lie the motor (postganglionic) cells for the muscles of the bladder. These are antagonistic to the hypogastric supply mentioned above. It is evident, therefore from the above that for the main mass of the vesical musculature the motor cells are placed not in large isolated ganglia but in a plexiform arrangement upon the surface of the organ. This mechanism forms an analogy to that found in the small intestine where the plexus of Auerbach

holds a similar arrangement to the fibers carried in the vagus (9). Further upon stimulation of the pelvic nerve, there ensues an inhibition of the internal sphincter of the bladder (trigonal area) together with the anal sphincter of the anus.

Thus it appears that the vesical plexus contains the motor fibers for the vesical endodermal muscles and the inhibitory fibers for the internal sphincters. If we consider this dual innervation of the bladder through the thoraco-lumbar and through the sacral outflow it becomes evident that the sympathetic impulses control the mechanism of vesicular filling in that they bring about contraction or increased tone of the sphincter area and an inhibition or condition of decreased tonicity of the muscular walls of the bladder. On the other hand the pelvic or sacral supply directs the mechanism of emptying of the bladder since these impulses cause an increased degree of tone of the bladder wall and inhibition of the vesical sphincter.

**Ureters.** The main innervation of these ducts is supplied by the thoraco-lumbar outflow via the hypogastric nerve. The work of Fagge (10) indicates that muscular movements which show themselves either as augmented rhythmic or group effects rather than single contractions result from the stimulation of the hypogastric nerve. After ergotoxin, adrenalin which previously placed upon the ureter evoked motor reactions now inhibits the movements of the ureteral muscles. Here again evidence is present that motor and inhibitory (postganglionic) cells from the ureters reside in the same nervous focus, in this case the plexus on the walls of the ureters.

**Uterus.** This organ receives its nerve supply from the thoraco-lumbar autonomic, via the second third fourth and fifth lumbar nerves. Apparently previous to pregnancy (virgin uterus) inhibitory effects are the only ones to be obtained from stimulation of the hypogastric nerve or upon direct administration of adrenalin. The pregnant uterus however under these conditions, shows normally a contraction. Evidently during pregnancy either motor cells have been developed or what seems more probable

motor cells previously inactive have been brought up to the threshold of irritability by the hormonal action of substances formed from the foetus or corpus luteum. However that inhibitory impulses are likewise active at this time can be shown by the application of adrenalin following ergotoxin (11) under these conditions inhibition is the result.

*Gonads and their accessory organs* The ovaries and testes function as organs of internal secretion. That functional activity may be carried on without the immediate intervention of nervous control is quite evident from cases where a successful transplant vicariously assumes the duty of the normal organ. Hence although the gonads are distinctly governed by nervous impulses originating reflexly from various parts of the body and these are subject to transient variations in function, nevertheless these organs possess a degree of automaticity of reaction sufficient to allow them to secrete internally a proper amount of substance for the normal needs of the body. The autonomic supply to the gonads emerges through the thoracolumbar (sympathetic) division—second, third, fourth, fifth lumbar spinal roots (12). These fibers are carried over the hypogastric nerve; those for the ovaries passing through or ending in the plexus of the ovarian artery. These plexus are derived in part through communicating branches from the uterine and renal plexus. The testes and spermatic cord are innervated over the hypogastric; the neurones arborizing around cells in the spermatic plexus which also possesses correlating branches with the renal plexus. Short post-ganglionic fibers then pass from the cells in these plexus to the respective effector organs.

The prostatic muscles and vasa deferentia (13) undergo marked contractions when the hypogastric nerve is stimulated. This reaction is strong enough to cause emission of semen from the aperture of the penis (14). Therefore apparently ejaculation may occur without erection. Mislavsky and Bormann (15) state that secretory fibers to the prostate also pass over the hypogastric.

In contradiction to some previous authors, Langley and Anderson (16) believe that the sacral outflow over the pelvic nerve does not

carry any impulses to the internal generative organ.

The erection of the penis is largely a vaso-motor phenomenon although contraction of the ischio-cavernous and bulbocavernous muscles assist in the process through their power to interfere with and hence arrest the outflow of the increased amount of blood supplied through vasodilation to the cavernous sinuses (17).

According to Langley and Anderson (18) the vaso-dilator fibers of the testes and vulva in the monkey emerge from the cord through the second and third sacral nerves. These fibers also cause inhibition of the unstriated muscle of the penis (the retractor penis when present) and of the vulva (in the female). Some vasomotor fibers for these structures have been noted in the hypogastric but they produced mainly constrictor effects. Vasodilation seems to be effected over the sacral autonomic. Here we find vasomotor equilibrium effective through antagonistic effects mediated over two divisions of the autonomic system.

It would seem that the accessory generative organs rest under autonomic control in part over the sympathetic and in part via the sacral divisions; the functions mediated are largely vasomotor, motor and possibly secretory.

*Mammary glands* The results of experiments bearing upon the question of the innervation of these glands are conflicting. Undoubtedly their activity is controlled in part by hormones and by chalone as well. Vasomotor fibers are derived from the intercostal nerves of the fourth, fifth and sixth intercostal spaces; these are part of the thoracolumbar (sympathetic) outflow. The question concerning true secretory fibers remains undecided; even the experiments upon animals are inconclusive and conflicting. Undoubtedly the production of milk may be affected reflexly by impulses originating in other parts of the body or from the cortical areas of the brain. But it is doubtful as to whether these effects are the result of locally disturbed vasomotor conditions in the glands or are mediated by specific secretory nerves derived from the sympathetic system.

## THE ENDOCRINE ORGANS OTHER THAN THE GONADS

**Thyroid** Recently considerable light has been thrown upon the autonomic innervation of some of these glands. The later work of Cannon and Cattell (19) upon the pathway of secretory impulses to the thyroid points conclusively to that portion of the cervical sympathetic outflow which accompanies the thyroid arteries into the gland as the effective secretory nerve supply. Previously Rahe Rogers Fawcett, and Beebe (20) had discovered that stimulation of the superior thyroid vessels with their accompanying nerves or of the vagosympathetic trunk (in the dog) may make the iodine content of the disturbed lobe less than that on the other side. These results while significant were not conclusive since the decrease in iodine content of the stimulated side might have been merely the result of a discharge of *preformed* secretion. On the other hand Asher and Flack (21) after stimulating the superior and the recurrent laryngeals found that the depressor nerve initiates a greater decrease in arterial pressure and adrenalin raises it to a greater height than before. Since the intra-venous administration of thyroid extract caused in their hands, similar phenomena they concluded that these nerves conveyed secretory fibers to the thyroid. Schaefer (22) however could not confirm this effect of the thyroid injection. The results are inconclusive regardless of the question of the validity of the criterion established by Asher since the laryngeal nerves might carry thoracolumbar (sympathetic) autonomics even though they are derived from the cranial division (the vagus). In the animal used (the dog) the two divisions are in a combined trunk.

Cannon (23) employing differences in electrical potential appearing in the gland as evidence of secretory activity showed that stimulation of the sympathetic trunk high in the thorax evokes an action current after a latent period of three to five seconds. Any condition of the body which tends to influence the activity of the cervico-thoracolumbar autonomic impulses (sympathetic) will affect the degree of production of the hormone of the thyroid. In this connection it must be

mentioned that Bagley showed that extirpation of the superior cervical ganglion evokes an increased tolerance of carbohydrates. Hence hyperthyroidism becomes one of the correlating syndromes of sympatheticonia.

These findings possess some interesting significance in that they explain in a way other than the usual the beneficial results obtained in Graves disease following the ligation of the nutrient arteries. The benefits derived may possibly be ascribed to the diversion of the sympathetic supply carried into the thyroid on the walls of the arteries rather than to the decrease in blood supply (24).

**Pituitary** Weed Cushing and Jacobson (25) after a study of the effect of stimulating the superior cervical ganglion (sympathetic) upon the production of glycosuria conclude that the phenomena observed are to be ascribed to impulses traveling over the sympathetic pathway to the pituitary and evoking in this organ a glycogenolysis and glycosuria. Since the Bernard *piqûre* experiment according to these findings will cause glycosuria even after transection of the spinal cord above the splanchnic outflow the conclusion seems inevitable that the well-known discharge of glycogen from the liver which is the immediate cause of this form of glycosuria must be initiated in this case not by excessive splanchnic stimulation but by increased sensitization of the endings of these fibers in the liver by means of the hormone from the pituitary. By this explanation pituitary glycosuria is explained along lines similar to that obtained by thyroid and adrenalin injection all three are brought about by mobilization of sugar derived from the liver.

**Pancreas** There appears to be little doubt but that cranio-autonomic fibers to the external secretory cells of this organ are carried in the vagus. The evidence concerning secretory fibers to the islands of Langerhans is not so definite. The fact however that transplants suffice to carry on the normal function of the organ and bring about the usual metabolism of carbohydrates renders it quite improbable that secretory fibers are of value in the normal economy of the gland.

**Adrenals** Earlier in this paper attention was called to the developmental relationship

existing between the chromaffin system and the autonomic neurones. If the chrome cells of the medulla are representatives of the post ganglionic neurones of the autonomic outflow then the so-called secretory fibers to the adrenal carried in the thoracico-lumbar system (sympathetic or splanchnic) constitute in reality preganglionic fibers. It is only what one would expect, therefore that stimulation of the splanchnic fibers would bring about an increased secretion of epinephrin. This phenomenon observed first by Dreyer (26) and since by so many other investigators requires no further consideration. At this point emphasis will merely be laid upon the control of epinephrin secretion centered in the thoracico-lumbar (sympathetic) division of the autonomic system and that the phenomena observed as the result of administration of adrenalin whether they result in excitation or inhibition are the same as those initiated by stimulation of the sympathetic nervous system. It is for this reason that adrenalin is denoted as a sympathicomimetic substance.

*Thymus.* Although the thymus receives branches from the vagus (cranial autonomic) and from the sympathetic (thoracico-lumbar) trunks nothing is known concerning the character of the nervous control of these organs other than the vasomotor outflow. Even in this case the pathway of the fibers has not been traced.

*The pineal body* is said to be supplied with sympathetic fibers which pass into the gland on the walls of the nutrient arteries. We are still in the dark concerning the nerve supply with reference to its probable secretory function.

In summing up what has been said concerning the autonomic nerve supply of the endocrine organs neglecting the vasomotor innervation and centering our attention upon their secretory function it is quite evident that the adrenals the thyroids and the pituitary body are innervated by the thoracico-lumbar division. Individual stimulation of these glands over this pathway or their automatic hyperactivity evokes a mobilization of the glycogen of the liver and a consequent hyperglycemia and glycosuria.

The nervous control of the internal secretion of the pancreas is not established. Since the function of this organ is distinctly antagonistic in carbohydrate metabolism to the adrenals pituitary and thyroid it would be interesting to speculate as to whether perhaps this organ did not receive its internal secretory nerve supply from the vagus just as it is innervated by this nerve for its external secretory function. If this should eventually be found to be true then a further antagonism of effects between the cranial and the thoracico-lumbar autonomies would have been established in relation to the production of carbo-metabolic controlling hormones. Attention must also be called to the fact that hyperactivity of the thyroids pituitary and adrenals eventuate in symptoms of excessive sympathetic excitation i.e. sympathicotonia. We cannot discuss at this time the individual mechanisms of these three endocrine glands whereby these symptoms of disordered function are aroused.

#### VAGOTONIA AND SYMPATHICOTONIA

The discussion of the autonomic nervous system in relation to its constituent divisions should have brought clearly in evidence the antagonism of function radiated on the one hand by the outflow of fibers from the middle of the central nervous system—the cervico-thoracico-lumbar or sympathetic system and on the other by the autonomic system. It has been pointed out that in almost every instance the vegetative organs are innervated by a dual autonomic nerve supply and the balanced or dynamic equilibrium which exists in the organ is the resultant of the antagonistic forces supplied by the two divisions of the autonomic system. Since each organ exists in a state of tonic innervation derangements in equilibrium may be initiated from a disturbance of this innervation and the direction of the reaction from the center of equilibrium will be determined by the character of the change occurring in the nervous regulation. For example a condition of equilibrium as seen in the rate of the heart is controlled by two sets of antagonistically acting impulses, those attempting to increase the rate viz the cervico-thoracico-lumbar outflow

(sympathetic) the *accelerator* nerve and those traveling over the *cranio-bulbo* pathways (vagus) the *inhibitory* nerve. A disturbance of this equilibrium in either direction may be occasioned in two ways. Acceleration may be evoked either by stimulation of the *accelerator* (sympathetic) fibers or by the inhibition of the *inhibitory* (vagus) impulses. Like wise diminution in rate may be brought about either by augmented vagus effect or by inhibition of sympathetic action. If the rate increases it is usually ascribed to augmented sympathetic effect or a sympathetic tonia but it must not be forgotten that a similar symptom may be aroused by a decrease in vagus control or decreased vagotonia.

According to the present conception attached to vagotonia and sympathicotonia, these syndromes represent varying in creases in reactivity of the corresponding divisions of the autonomic system. In sympathicotonia, there exists a condition of heightened irritability of *cervico-thoraco-lumbar* autonomics and the symptoms which comprise the syndrome of this clinical manifestation are the result of exaggerated effects or overstimulation of this division of the autonomic. Vagotonia represents a similar derangement of equilibrium in the organs innervated by the *cranio-bulbo-sacral* outflow. The term vagotonia is unfortunate for although the vagus does supply by far the greatest part of the domain of the cranio-bulbar outflow nevertheless ocular symptoms are important in vagotonia with which the vagus has nothing to do. To obviate this discrepancy between concept and terms, cranio-bulbar distribution is spoken of as the area of the extended vagus. Again it must be emphasized that a vagotonia may also result from a corresponding decrease in irritability of the effector organs innervated by the antagonistically functioning *cervico-thoraco-lumbar* (sympathetic) outflow. The following is a list of symptoms grouped under the head of sympathicotonia and vagotonia, each set divided according to that portion of the autonomic outflow to which differences in reaction of the corresponding effector organs explain the appearance of the symptoms.

CRANIO-BULBO-SACRAL OUTFLOW	CERVICO-THORACO-LUMBAR OUTFLOW
Hyperactivity results in ap- tonia	Hyperactivity results in sym- pathotonia
Third Nerve	Cervical sympathetic
*Mydriasis	*Lower lipa
*Accommodation spasm	*Mydriasis
*Narrowed eye slit	*Accommodation paralysis
*Lachrymation	*Narrowed eye slit (diagnostic)
	*Dryness of eye
Esophagus	*Esophagismus
	*Dryness of mouth
	*Mucous lips
	*Interference of swallowing (dys- phagia)
Fifth and Seventh Nerve	
*Insatiation	Thoracic (lumbar autonomic)
*Excessive weakness	*Tachycardia
Vagus	*Paroxysmal Acheir
*Stomach & uterus	*Atony—Stomach, intestines
*Esophagus	
*Achyrdia (removal by strep- to)	*Type acidity
*Functional disturbances	*Atonic constipation
*Gastric antral reflux	*Flaccid stomach
*Achyrdia	
*Respiratory pain	
*Larynx hyperemia	
*Hyperacidity	
*Flaccid stomach	
*Laryngeal edema	
*Atonic constipation	
(Diarrhea)	
*Biliary colic (relieved by atropine)	
Sacral autonomic—	Lumbar sympathetic
*Pruritus, odor	*Atony of colon
*Increased tone bladder	*Relaxed bladder
(polyuria)	*Symp. sacral and anal sphincter spasms
*Hyperhidrosis	*Hypohidrosis
*Zosteriform	*Erysipelas
*Dermatographia	*No dermatographia
*Increased fat and carbohydrate tolerance	*Decreased fat and carbohydrate tolerance
Most frequent and significant symptoms	

#### ACTION OF CERTAIN PHARMACOLOGICAL SUB- STANCES IN VAGOTONIA AND SYMPA- THICOTONIA

In epinephrin, elaborated by the medulla of the adrenals we possess a hormone whose function consists in sustaining the sympathetic factor in the dynamic balance. It is sym-  
pathicomimetic and the reactions which it evokes are those called forth by the stimulation of cervico thoraco-lumbar fibers of the autonomic system. It might be supposed that the symptoms of sympathicotonia represent a disturbance in balance in the organs dually innervated, a disturbance initiated by an increase in the amount of epinephrin in the blood whereby there is effected an increased irritability of the sympathetic myoneural junctions in the effector organs. When such a syndrome has made its appearance the individual is extremely sensitive to adrenalin. The Loewi phenomenon is positive in these cases, i.e. adrenalin installed into the eye brings about mydriasis. The increased tonus of the

dilator pupillæ innervated by the cervical sympathetic is able in the presence of adrenalin to more than offset the tonus of the sphincter derived from the third nerve and hence there results a dilation. Normally the tonus equilibrium cannot be so easily disturbed.

Some or all of the vagotonic symptoms can be experimentally produced by injecting pilocarpine or acetyl choline into the blood stream. Pilocarpine is more active upon the glandular organs of this system. Acetyl choline however which Dale and Ewins (8) obtained from ergot appears to possess a general stimulating effect upon the whole cranio-bulbo-sacral domain of innervation. Vagotonics are extremely sensitive to pilocarpine and the symptoms are alleviated by means of the antagonistically acting atropine thus restoring the physiological balance to its more normal position. Eppinger and Hess (27) believe that vagotonia represents a neurosis with a specific and characteristic syndrome or disease picture. They regard it as a functional autonomic system disease for the reasons stated above. These symptoms appear therefore in patients of vagotonic disposition which shows itself as a tendency toward an abnormal irritability of some or all of the myoneural junctions in the effector organs supplied by this division. Under such an incipient state of disturbed equilibrium an adequate stimulus which may be normal in character or amount suffices to upset the balance in the direction of cranio-bulbo-autonomic reaction and the symptoms of vagotonia result. It is of course to be understood that the whole domain of vagotonic innervation does not undergo an equally distributed disturbance of balance and in some cases patients present cardiac or ocular or gastro-intestinal reactions while the other cranial or sacral autonomic reactions remain unaltered.

The diagnosis of vagotonia (28) is determined as follows:

The average normal pulse and respiration rates are taken the blood pressure estimated and smears made for a differential count (eosinophiles). Pilo-

The term autonomic employed by these writers signifies the cranio-bulbo-sacral division of the whole autonomic system. It is used in contradistinction to the sympathetic system.

carpine 0.01 gm (grs 1/6 to 1/20) is given hypodermatically and during the following hour the general condition of the patient is observed as to sweating salivation lacrymation increase in nasal secretion fibrillation blushing chills and cold extremities. Pulse and respiratory rates are determined every two to three minutes the blood pressure at longer intervals. At the end of the hour the eosinophiles are counted from a blood smear. An increase in carbohydrate tolerance and a cardiorespiratory arrhythmia are pathognomonic.

The method of diagnosis of sympathicotonia is as follows:

The day before the test 100 grams of dextrose are ingested on an empty stomach the first five hourly specimens of urine are collected and polarized. The following day 100 grams of dextrose are again ingested, pulse respiratory rates and blood pressure determined and one half hour later epinephrin 0.005-0.001 grams given hypodermatically. Pulse and respiration are examined every two minutes and the patient observed for tremor and palpitation. At the end of one hour smears are examined for eosinophiles and the urine collected hourly for five periods. A positive reaction is shown when there is an increase in eosinophiles a rise of at least 15 millimeters of mercury in blood pressure a decrease in carbohydrate tolerance, and the development of tremors and sometimes cardiopalpitation.

Considerable significance is to be attached to the attempt which has been made to correlate pharmacological action of certain substances in some cases hormones and these clinical manifestations. Substances that are functionally antagonistic have been compared in their physiological action with abnormal states of deranged equilibrium. Thus epinephrin is *sympathicomimetic* in its action. The effect of this hormone is to simulate reactions which can be evoked experimentally by stimulating any of the domains of innervation of the cervico-thoracic lumbar outflow. Other hormones possess similar effects as for example those from the thyroid and pituitary but the reactions are not extended over such a wide field of autonomic innervation. On the other hand ergotoxin functions as an *inhibitor* of some of these sympathicotropic hormones although its peripheral effect is circumscribed. In one sense therefore it may be conceived as vagotropic.

Acetyl choline appears as the most general antagonist of adrenalin in that it augments

the reactions of the effector organs supplied by the cranio-sacral autonomies (8) Pilocarpine as we have seen is also *vagomimetic* although its effect is mainly centered upon the glands and the heart. Other substances such as muscarin physostigmin and picrotoxin must be considered as vagotonic stimulants but their reactions are more specifically located. Their domain of action is much circumscribed. Atropin functions as an inhibitor of this class of substances. Where pilocarpin stimulates atropin inhibits. It must be evident from what has been said before that the effect of atropine as an inhibitor of the reactions produced by vagotropic substances must be similar to that of adrenalin which stimulates the antagonistic sympathicotonic reactions. From this standpoint it is clear why atropine and adrenalin may in general produce similar reactions although the mechanism by means of which the change is evoked is different in the two cases. Atropine as an inhibitor of vagotonic excitability and adrenalin as a stimulant to antagonistic sympathetic irritability would be indicated in cases of vagotonia. Conversely pilocarpine as an augmentor of irritability in the cranio-bulbo autonomic realm (extended vagus) and ergotoxin functioning as a paralyzer of the antagonistic thoracico-lumbar autonomic (sympathetic) would in general initiate similar reactions and might similarly be considered and indicated in sympathicotonia.

In general it has been assumed that vagotonics are hypersensitive to pilocarpine and sympathicotonics to adrenalin. An investigation of this pharmacological relationship based upon antagonistic effects and the clinical manifestations grouped under the head of vagotonia and sympathicotonia leads us however to view with suspicion any attempt to draw hard and fast lines around these antagonistic relationships whether pharmacologic or clinical (29)

Granted that these syndromes represent fairly well defined entities as to causation, it is self-evident that in no two cases will the whole domain of innervation of either division of the autonomic be equally affected. Certain symptoms of vagotonia will be present and

exaggerated in one patient and absent in another and this is also true for sympathicotonia. The results of Barker (30) appear to answer in the negative the question, as to whether an antagonism of clinical manifestation corresponding to that of pharmacologic action really exists. Exaggerated tonus in one reciprocally antagonistic system does not predicate a decrease in tonus in the other. Pharmacodynamic reaction and clinical symptoms agreed in only seven out of nineteen cases. In two cases of pilocarpine sensitivity the patients had sympathetic signs almost as prominent. In epinephric unstable patients, vagotonic signs predominated, and hence both systems appeared to be hypersensitive. This may be stated merely by way of a warning so that too much must not be expected from this new field of visceral diagnosis. However Eppinger and Hess deserved much credit in bringing together seemingly unrelated functional disturbances and linking them with more circumscribed nervous causes. Their conception of the matter must, however be considered somewhat in the light of a working hypothesis and be treated accordingly.

#### SUMMARY

The autonomic nervous system plays a very important rôle in the combination of chemical and physical forces upon which rests the physiological state of dynamic equilibrium so essential for the maintenance of life. It is intimately integrated with chemical correlation through hormones, each system tending to regulate the other. Although the autonomic impulses are in the main independent of volition, nevertheless the effector organs innervated by these fibers can be brought into reaction through reflexes whose centers exist in the central nervous system and whose afferent arcs may originate in the cortical areas. Certain pseudo-reflexes (axon reflexes) are possible in this system in contradistinction to the cerebrospinal outflow.

The autonomic system is divided according to the portion of the central nervous system from which the outflow of preganglionic fibers takes place. (a) The *cranio-bulbo* autonomic includes preganglionic fibers in the third, fifth, seventh, tenth, and eleventh cranial

nerves (b) The *thoracico-lumbar* autonomic covers the outflow between the second dorsal and third lumbar anterior roots. This is ordinarily called the sympathetic system (c) The *sacral* autonomic is supplied by the second and third anterior sacral roots.

Considerable importance rests upon the close embryological development of the chromaffin and autonomic systems. Both are developed from the neural crest cells which eventually form the posterior root ganglia. In the lower forms (coelenterates) the former represents the latter as groups of chrome staining cells placed similar to the sympathetic ganglia. As the autonomic outflow of fibers becomes more pronounced in the higher mammals the chromaffin system assumes less and less prominence until at present in mammals it is restricted in the main to the medulla of the adrenal bodies. These cells represent postganglionic fibers of the sympathetic system. Most of the effector organs innervated by the autonomic outflow receive a dual supply from the thoracico-lumbar division on the one hand and the cranio-hulbo or the sacral portion on the other. The effect of the former is antagonistic to the latter.

The state of equilibrium determined by this extrinsic nervous control is dependant upon the ebb and flow of these two antagonistic set of impulses. There is also distinct evidence of reciprocal innervation in the autonomic system similar to that shown by Sherrington to exist in the cerebrospinal outflow. This mechanism is of exceeding advantage in the automatic filling and emptying of the small and large intestine, the biliary and urinary bladders. The uterus and ureters are also under autonomic control. The hormones and the autonomic system also possess reciprocal control over each other. Stimulation of the cervical sympathetic increases activity of the thyroid and pituitary glands.

Epinephrin exerts a sympathicomimetic effect through its action on the same peripheral mechanism as the thoracico-lumbar autonomic impulse. Pilocarpine reacts similarly upon the cranio-hulbo-sacral autonomic system but more particularly upon the secretory fibers. This type of substance

has been termed vagomimetic since the effects of the vagus as a part of this division of the autonomic are the most prominent and wide spread. Acetyl choline was shown by Dale to simulate more closely the general effects of bulbo-sacral stimulation. Atropine removes the effects of vagomimetic substances or prohibit the onset of the effects. A similar paralyzant for the sympathetic system has not come to light, unless we consider ergotoxin as fulfilling the conditions.

Attempts have been made to clarify the pathology of the vegetative organs by grouping together as a symptom-complex certain disturbances of the equilibrium in the autonomic system in its widest sense. Some of the symptoms of vagotonia, so called, may be ascribed to an increased activity of the organ or tissues supplied by the bulbo-sacral autonomic or a similar set of conditions may arise following a decrease in the power of the antagonistic impulses flowing over the sympathetic. Patients exhibiting such a syndrome are excessively reactive to pilocarpine. Other abnormal states occur as the result of augmented reactivity of the sympathetic or a decrease in the strength of bulbo-sacral autonomic outflow. Such a condition is given the name of sympathicotonia. These patients are sensitive to adrenalin and become better after the administration of atropine. Certain methods are in vogue for the determination of the conditions of vagotonia or sympathicotonia. Do these clinical pictures represent entities of abnormal function? What is their value in diagnosis?

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# CLINICAL CONGRESS OF SURGEONS OF NORTH AMERICA

*Eighth Annual Session, Chicago October 22 to 27, 1917*

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## CHICAGO TO ENTERTAIN CLINICAL CONGRESS OF SURGEONS

### GREAT INTERNATIONAL MILITARY SURGICAL PROGRAM

THE great European war in which the United States is to take so active a part, has brought about many changes in the medical world so that the Executive Committee of the Congress after consultation with members of the New York Committee on Arrangements has found it advisable to postpone until next year the meeting originally planned to be held in New York City in October and to hold the eighth annual session of the Congress in Chicago during the week of October 22.

Four great war meetings at which the notable advances in methods of caring for the sick and wounded as developed in the present war will be discussed by such eminent authorities as Dr Alexis Carrel Sir Berkeley Mowbray of Leeds England Dr Joseph A Blake Dr George W Crile Colonel Thomas H Goodwin R.A.M.C. with other official representatives of the medical services of the allied nations will provide the chief literary feature of the session. The papers read at these meetings together with the discussions will summarize the progress made in all branches of surgery in the war the subjects under consideration to include reconstruction surgery as developed in the military hospitals in England and France the newest methods in the treat-

ment of infections fractures burns brain and cord surgery plastic surgery chest surgery together with the application of these methods to civil practice thus providing some of the greatest symposia as to men and subjects ever presented at a medical meeting in this country.

An important feature at headquarters will be the military service bureau, to be established in one of the large rooms at the Congress Hotel, where representatives of the Surgeons General of the Army and Navy and the State Committees will be gathered to answer all inquiries and give complete information to all those interested in the medical services of the Army and Navy.

### CLINICS AND DEMONSTRATIONS

As at previous sessions of the Congress clinical demonstrations in the hospitals medical schools and laboratories will occupy the morning and afternoon hours of each day the evenings being devoted to literary sessions. The plans of the Committee on Arrangements provide for a complete showing of the city's clinical facilities in every branch of surgery including gynecology obstetrics, genito-urinary surgery orthopedics surgery of the eye ear nose throat and mouth

together with special demonstrations in radiology, experimental surgery, surgical pathology, etc. Every clinician of ability and reputation in Chicago will participate and under the leadership of Dr. Albert J. Ochsner as chairman, an effort will be made to outdo the successes of the two previous meetings held in this city. A representative committee of surgeons is now preparing a schedule of such clinics and demonstrations which it is expected will be published in the next issue of this journal.

The president-elect Dr. John G. Clark of Philadelphia will deliver the annual address at the presidential meeting on Monday evening in Orchestra Hall. On Tuesday, Wednesday and Thursday evening the sessions will be held in the Gold Room of the Congress Hotel. The program for these evening sessions now being prepared by the Executive Committee of the Congress will be published in the next issue of this journal.

A feature which proved of great interest at the Philadelphia session, the cinematographic exhibitions of surgical operations, will be repeated at this meeting, depicting some of the newer as well as the classic operations as performed by eminent specialists. These will be given each afternoon between five and six o'clock in the Gold Room of the Congress Hotel.

The Committee on Arrangements as selected by the Executive Committee of the Congress is as follows:

A. J. OCHSNER, CHAIRMAN	
E. W. ALLEN	R. DOLPH HOLMES
W. L. BRYAN	CHARLES E. KAHN
CHAS. W. B. BRYAN	ALFRED B. KAMM
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A. E. HALLSTAD	T. J. WATKINS
WILLIAM M. HARRIS	WILLIAM H. WILDER
WILLIAM HENBERT	CARLY A. WOOD

At a meeting of this committee held in Chicago on August 15th the committee was formally organized and plans outlined for the forthcoming session. Dr. Robert T. Gillmore was elected secretary.

#### LIMITED ATTENDANCE—ADVANCE REGISTRATION

The popularity of these clinical meetings has proved so great that it was found necessary to adopt the plan of limiting the attendance and requiring advance registration. This plan has worked satisfactorily at previous sessions and will be enforced at the Chicago meeting thereby ensuring accommodations at the clinics for each one who receives a membership card. A survey of the operating amphitheaters, lecture rooms and laboratories in the hospitals and medical schools as to their capacity for accommodating visiting surgeons has been made and the limit of attendance will be based thereon.

Letters received at the office of the Secretary, general evidence great interest in the plans for this fall's meeting and it is confidently expected that registrations up to the limit of attendance will be received some weeks in advance of the meeting so that immediate advance registration is necessary to ensure receiving a membership card. At both the Boston and Philadelphia sessions several hundred were disappointed in not receiving membership cards due to the fact that their applications were received after the limit of attendance had been reached.

Members planning to attend the Chicago meeting are urged to make their hotel reservations at an early date. In addition to the Congress, the LaSalle and Sherman hotels are recommended to members as offering most excellent accommodations at reasonable rates.

Application has been made with the several railway associations for reduced fares for members attending the Chicago meeting. It is expected that such reduced rates will be granted in the territory lying east of the Mississippi River including eastern Canada. A definite announcement with regard to reduced fares will be published later.

#### HEADQUARTERS

Headquarters will be established at the Congress Hotel where the Gold Room, Florentine Room, Elizabethan Room and other large rooms, conveniently located on the first and second floors of the hotel have been reserved for the use of the Congress during the entire week, providing ample space for the evening and business sessions, cinematographic exhibitions, registration and ticket bureaus, bulletin boards, etc.

To each member registering in advance will be issued a formal receipt for the registration fee which receipt is exchangeable for a membership card at headquarters at the Congress Hotel.

when making his registration upon his arrival in the city. Headquarters will be open on Sunday afternoon, Oct 21st for the convenience of all members arriving in the city on that day. The clinical program for Monday will be bulletined at headquarters at the Congress Hotel on Sunday, and on the afternoon of each day there will be bulletined at headquarters a complete accurate program of the clinics and demonstrations to be given on the succeeding day. Printed programs will be issued each morning containing the complete clinical program with announcements for the evening sessions, business meetings, etc.

#### REGISTRATION FEE

The constitution of the Congress provides that a registration fee shall be required of each member attending an annual meeting, there being no annual dues for members of the Congress. Receipts from registration fees provide the funds with which to meet the expense of preparing for and conducting the annual meetings, so that no financial burden is imposed upon the members of the profession in the city entertaining the Congress.

#### SPECIAL TICKETS

Attendance at all clinics and demonstrations will be controlled by means of special tickets, the number of tickets issued for any clinic or demonstration being limited to the capacity of the room in which the clinic or demonstration is to be given. The general rule will be that a member may have two tickets for each day, one for a morning and one for an afternoon clinic. For certain clinics where the accommodations are limited and the demand for tickets is heavy, it will be necessary to establish a rule whereby a member may have only one ticket for such clinic during the week.

The use of special tickets has proven an efficient means of providing for the distribution of members among the several clinics and ensures against overcrowding at any clinic. Special tickets will be issued each morning for the clinics and demonstrations to be held that day, a complete schedule of the day's clinics having been posted on the bulletin board on the afternoon of the preceding day, and a printed program distributed in the morning.



# SURGERY, GYNECOLOGY AND OBSTETRICS

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## A FURTHER REPORT OF EIGHT CASES OF SYPHILIS OF THE STOMACH<sup>1</sup>

By WILLIAM A. DOWNES M.D. F.A.C.S. NEW YORK

IN March 1915 in a paper read before the New York Surgical Society I reported eight cases of syphilis of the stomach. This report<sup>2</sup> included roentgenologic findings made by Le Wald. The patients had been under our care from 6 to 18 months and we felt that the clinical and laboratory data given was sufficient to establish the diagnosis in each instance. However the general opinion was expressed that a late report upon their condition would be desirable before accepting the diagnosis as final. As all of these patients have now been followed from 2 to 3 years and 6 months I trust that further observation of their progress may be of some interest to the members of this society.

Before taking up the case histories it may not be amiss to review briefly the more important clinical manifestations of the disease. As to the frequency of the condition Smithies<sup>3</sup> has recently reported 26 cases occurring in the examination of 7,545 patients suffering from all types of dyspepsia (0.3 per cent). In 1,603 of these patients there was apparently pathologic changes in the stomach and duodenum of this number 1.6 per cent were luetic. Of this same group 13.3 per cent had gastric cancer 18.7 per

cent gastric ulcer and 39 per cent duodenal ulcer. While we are unable to give at this time accurate statistics from the stomach cases occurring at St. Luke's Hospital where the eight patients comprising this report were observed I believe that the percentage of syphilitic patients with definite evidence of stomach disease will run even higher than that given by Smithies.

Syphilis of the stomach may be congenital or acquired. Two of the cases here reported were undoubtedly of congenital origin one in a female aged 14 the other in a male aged 17. A history of stomach trouble extending back many years was obtained in both instances. In the 6 cases of the acquired type two gave definite histories of chancre while in the remaining 4 there was no history of primary infection. In this group there were 3 males and 3 females the youngest was aged 22 the oldest 63.

The lesions vary from a diffuse syphilitic gastritis with round-cell infiltration spreading through the submucous tissue to localized or general gummatous infiltration involving all the coats. These gummatous deposits may be single or multiple and not infrequently ulcerate. One portion of the stomach wall may remain infiltrated while another passes on to ulceration or in the healing stage becomes cicatricial. The irritation of the peritoneal coat results in perigastric ad

<sup>1</sup>Downes, W. A. and Le Wald, Leon T. Syphilis of the stomach. J. Am. M. Ass. 5 M. y. 29. 8.  
<sup>2</sup>Smithies, Frank. Syphilis of the stomach. J. Am. M. A. 9 5  
<sup>3</sup>4. Dec. 57. 7.

Read before the Southern Surgical and Gynecological Association, White Sulphur Springs, West Virginia, December 3, 1916.



Fig. Case 3. Girl, age 4. Note dumbbell-like appearance due to sclerosis of body of stomach. After gastro-enterostomy most of food goes through opening but enough passes through constricted portion to outline it. Not compensatory dilatation of oesophagus.

lesions of varying extent. Definite pyloric obstruction may occur as a result of the gummatous infiltration, cicatrization of the ulcer or from the perigastric adhesions. It is for the relief of this complication that surgery plays an important rôle in the treatment of the disease. Besides the lesions in the stomach wall other evidences of lues are usually found, such as changes in the liver capsule, gummata of the liver, extensive involvement of the gastrohepatic and gastrocolic lymph glands as well as other evidence of a generalized syphilis.

The symptoms of gastric syphilis taken as a whole vary but little from those of other stomach lesions of similar extent, however, upon careful analysis several striking differences become apparent. The pain which is a most constant symptom lacks the periodicity of that occurring in the average simple ulcer, and it is not so much influenced by the taking of food. It is frequently worse at



Fig. Case 4. Woman, age 34. Note hour-glass constriction with long channel between pouches. Condition confirmed by operation and relieved by breaking up of perigastric adhesions and performance of gastro-enterostomy in the lower pouch.

night and is often referred to as gnawing in character. Vomiting is a persistent and annoying symptom. It was present in all of our cases. Hemorrhage is not so frequent as in peptic or duodenal ulcer which is rather remarkable when the duration and extent of the lesion are taken into consideration. A striking feature of the disease clinically is the rapid and not infrequently extreme loss of weight. Gastric analysis was made in 6 of our cases with the following results. In Cases 1, 7, and 8 free hydrochloric acid absent, combined acidity 32, 16, and 14 respectively; in these cases the lesion was extensive, involving a large portion of the stomach wall. In Cases 2 and 3 in which the lesion was confined to the pylorus free hydrochloric acid was 30 and 36 with a total acidity of 52 and 70. In Case 4 in which there was hour glass constriction the analysis showed free hydrochloric acid 13, total acidity 34. Lactic acid was absent in each case. The gulac test for blood was positive in 5 cases. These findings would seem to suggest that there is an absence of free hydrochloric



Fig. 3. Case 5, woman, age 23. Note deformity at pyloric third of stomach due to sclerosis. Note close resemblance to new-growth. Diagnosis of syphilis confirmed by operation and microscopic examination of section of stomach wall. Symptoms relieved by gastro-enterostomy but deformity persisted.

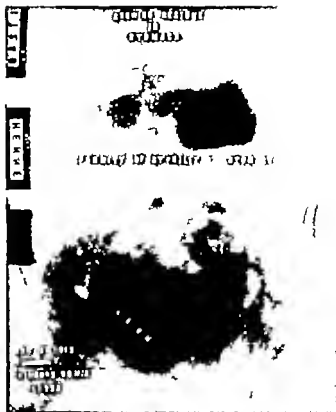


Fig. 4. Case 6, boy, age 17. Note deformity at junction of pyloric and middle thirds of stomach. This case responded to medical treatment but the deformity remained.

acid and a low total acidity in the cases with extensive involvement of the gastric mucosa.

The diagnosis of this condition can be established with a fair degree of certainty if the clinical and laboratory findings are given proper consideration. In the congenital cases the family and previous history of the patient, his general development and appearance with the symptoms of chronic stomach trouble should arouse suspicion. The acquired cases may be more difficult to diagnose but the past history plus unusual symptoms should suggest that the case is out of the ordinary. In both types the course of the disease differs from the simple gastric or duodenal ulcer in that it is influenced but little by dieting and the ordinary methods of treatment and it is unlike malignancy in that there is not the steady and continuous progress to a fatal termination. A positive Wassermann reaction with roentgenographic findings of persistent and unusual deformity of the stomach establish the diagnosis beyond much doubt. In view of the accuracy of

modern laboratory aids to diagnosis one hesitates to refer to the so-called therapeutic test but the value of anti-syphilitic treatment in confirming the diagnosis of syphilis in general cannot be ignored. Such treatment may be of temporary benefit in ordinary ulcer or even cancer of the stomach but the improvement is of short duration whereas in the luetic cases there is almost immediate and continued relief from symptoms.

Owing to the close resemblance between syphilitic infiltration and tuberculosis and the difficulty of staining for spirochæta pallida, the pathologic diagnosis of syphilis of the stomach is extremely difficult to establish. Specimens were removed for examination in 2 of our cases, but a positive diagnosis from this tissue could not be made—both were negative for tubercle bacilli as well as for spirochæta pallida.

Vigorous anti-luetic treatment should be instituted as soon as the clinical diagnosis is established. If the lesion has not progressed to the cicatricial stage causing ob-





Fig. 5. Case 7, man, age 6. Note deformity of body of stomach and pyloric region, due to sclerosis. Note small size of stomach and rapid emptying time: exposure made three minutes after full bismuth meal. No complete filling of duodenum. This case responded to medical treatment.



Fig. 6. Case 7 (two years and three months after treatment). Capacity of stomach greater suggesting less distention. Stomach empties less rapidly.

struction at the pylorus or hour glass contraction has not taken place from cicatrization in the body of the stomach or from perigastric adhesions the symptoms will be controlled almost immediately. On the other hand should symptoms of obstruction be present either from gummatous infiltration or cicatrization operative intervention may become necessary in fact demanded. Gastro-enterostomy is the operation of choice if the condition of the stomach wall will permit; if not jejunostomy is indicated to be followed later by whatever operative procedure is necessary to restore the stomach to a functioning condition. Efficient anti-luetic treatment may so improve the lesion that further operative interference may not be called for. As stated in our previous paper we are aware of the fact that all gastric ulcers syphilitic or otherwise have potential dangers and for this reason the advisability of excision and resection should be considered in every suitable case. It is my personal

belief however that since syphilis of the stomach is only the local evidence of a general disease no case should be subjected to more than the simplest form of operation, necessary to relieve urgent symptoms until after anti-luetic treatment has been given a trial. The after history of the cases forming this report support this belief.

#### PRESSENT STATUS OF CASES

In 5 of the cases gastro-enterostomy was performed in order to relieve symptoms of obstruction. In the remaining 3 even though vomiting was present roentgen examination demonstrated bismuth passing freely through the pylorus and for this reason operation was not indicated. Under appropriate treatment relief from symptoms in each case was rapid and up to the present time these patients have made just as satisfactory progress as those subjected to operation. We have recently learned that Case 4 died in August 1916 of Bright's disease. This patient had been observed in the hospital in February 1916 one year after the diagnosis of syphilis of the stomach had been made — suffering



Fig. 7 Case 8 woman, age 23. Note small size of stomach due to retraction from sclerosis of middle of body and adjoining pyloric region. Very rapid emptying time. Exposure made three minutes after bismuth meal. Note compensatory dilatation of oesophagus to make up for small size of stomach. Note complete filling of duodenum. This case responded to medical treatment, but deformity remained.

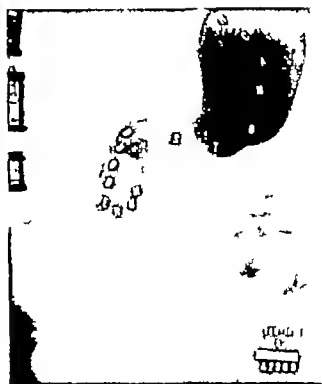


Fig. 8. Case 8 two years and a half after treatment. Note improvement in this case—similar to that in Case 7.

from syphilitic aortitis and myocarditis. Her Wassermann remained four plus and the chances are that death resulted from a generalized syphilis. She had held her gain in weight and the gastro-enterostomy plus treatment apparently had relieved the gastric symptoms.

The remaining 7 cases are well from a clinical standpoint in so far as their stomachs are concerned and are able to follow their usual vocations. Pain and vomiting have disappeared, there has been a gain in weight from 10 to over 50 pounds and their entire appearance has changed for the better. The most striking improvement has taken place in the two congenital cases—from stunted under-sized children they have developed and filled out to normal proportions. While treatment with salvarsan, mercury and the iodides has been carried out systematically in all the cases in only one of six in which recent tests have been made has the Was-

sermann reaction proved negative. Case 2 returned in October of this year complaining of distress after meals. Examination disclosed a large prostate gland with urinary retention. Removal of the prostate seems to have relieved the symptoms referable to his stomach, and he has now returned to work.

We cannot expect these patients to remain permanently free of stomach symptoms even though clinically cured at this time for as is well recognized there is the tendency for every case of syphilis to relapse however well treated. I shall therefore follow the future history of these patients with unusual interest. Whether or not we have been justified in assuming the diagnosis in this series of cases to be correct the fact remains that the symptoms have been controlled and the patients clinically cured for periods extending from one and one half to three and one half years.

A complete history of the cases was included in the paper already referred to and for that reason I shall review only such parts of the histories as are necessary to give a

clear idea of the condition of the patients at the time they came under our observation

CASE 2. H. D. female age 3. Congenital type. Admitted June 10, 1913. Pain & discomfort in the region of the stomach had been present as long as she can remember. There had been persistent vomiting for the past 6 months. The patient retained only liquid food. Weight 52 pounds. Wassermann four plus positive. Roentgen examination showed dumbbell-shaped dilatation involving the middle and pyloric portions of the stomach with almost complete obstruction. Gastro-enterostomy July 12, 1913. The operation was followed by butylated trephine irregularly for two years but has had a marked improvement during the past year. She now weighs 60 pounds. She is well and rarely complains of indigestion. The Wassermann remains three plus. Recent roentgen examination shows a little bluntness passing through the pylorus.

CASE 3. T. S. male age 63. Admitted April 6, 1914. Chancres 4 years ago. Achting pain in stomach 6 months irregular vomiting. Argyll Robertson pupils. Knee jerks absent. Weight 100 pounds. Roentgen examination showed a deformity of the pylorus with large six-hour residue. The Wassermann was four plus positive. The patient was put on anti-syphilitic treatment. She returned to the hospital June 10, 1914. She gained some weight but with continuation of obstructive symptoms. On June 27, 1914. Gastro-enterostomy was done. The patient resumed work in a few weeks. Constant treatment has been given since operation. The patient has recently had some discomfort in the stomach. He returned to the hospital October 9, 1914 for the removal of large prostatic. He was discharged in four weeks and is now back at work. Wassermann negative. Recent X-ray examination shows a very little if any change at pylorus with moderate six-hour residue.

CASE 3. D. D. male age 42. Admitted October 1, 1914. Pain of gnawing character in epigastric region for five years. Irregular vomiting up to eight weeks ago constant since that time. The patient had lost 20 pounds in weight. He denies primary sore. Marked arteriosclerosis. Wassermann four plus positive. Weight 55 pounds. Roentgen examination shows great dilatation of stomach due to obstruction at pylorus with large six-hour residue. Salvarsan and mild treatment for 10 days but without sufficient improvement to warrant longer delay in advising operation. November 3, 1914 gastro-enterostomy. He has continued treatment has gained over 30 pounds and is free from all symptoms. Roentgen examination September 19, 1915 shows no change at pylorus and gastro-enterostomy works satisfactorily. Wassermann four plus.

CASE 4. G. R. widow age 34. Admitted January 4, 1915. No history of primary infection. Pain has been present in region of stomach and

gall bladder for ten years. She has had one attack of jaundice. She has vomited at intervals, usually shortly after taking food. For years she has noticed swelling in the right upper abdomen recently tenderness has developed in this region. Wassermann four plus positive. Weight 115 pounds. Roentgen examination revealed an hour glass deformity of the stomach with retention of bismuth in the distal portion for 24 hours. January 3, 1915. Holecystectomy for hydrops. Gastro-enterostomy. The hour glass constriction is corrected by the adhesions to the parietal peritoneum and the liver. Convalescence straight for want of treatment followed intermittently. One year after operation returned to hospital with syphilitic aortitis, myocarditis, and nephritis. Discharged improved three or four weeks. Practically no stomach trouble since operation and has gained 20 pounds. Wassermann four plus. X-ray shows gastro-enterostomy working rather slowly. The patient moved to a distant city a few hours before she died in August 1916 of Bright's disease.

CASE 5. G. female age 3. Married three years. Admitted January 15, 1915. There is no history of infection. The husband gives four plus Wassermann. Child one year old also gives positive Wassermann. For the past eight months pain has been present in the stomach coming on shortly after eating. The pain is relieved by vomiting. Vomiting has been constant for two months. Palpation shows firm indurated mass in epigastrium. Weight 88 pounds. Roentgen examination shows filling defect in pyloric third of stomach with retention of bismuth for 4 hours. Gastro-enterostomy January 7, 1915. Rapid recovery. Put upon anti-syphilitic treatment which has been continued to present time. Is free from all stomach symptoms. X-ray shows gastro-enterostomy working satisfactorily but deformity in pyloric region still persists. Wassermann remains positive.

CASE 6. W. H. male aged 7. Admitted October 30, 1913. Congenital type. For five years there has been discomfort in the region of the stomach. There have been acute attacks of intermittent pain recently. The patient vomits at intervals. He lives almost entirely on fluids. Weight 63 pounds. Height 5 feet 5 inches. Wassermann four plus. Referred to us for appendectomy with the idea that the stomach symptoms were possibly reflex. Roentgen examination showed peculiar deformity of stomach suggesting syphilitic infiltration. Bismuth passed out fairly rapidly and it was decided to push anti-syphilitic treatment with the result that there was marked improvement. He has continued to gain to present time. Weight 66 pounds. Eats all sorts of food and feels well. Roentgen examination December 3, 1914 still shows deformity but stomach empties in six hours.

CASE 7. D. F. male age 6. Admitted August 1914. Primary infection many years ago. Eighteen months ago the patient began to have sharp

cutting pains in stomach which were worse at night, and had no relation to meals. For six months he has been able to take liquids only. Weight 97 pounds. Wassermann four plus positive. Roentgen examination showed deformity involving the pyloric half of the stomach with peculiar narrowing of the caliber of this portion. The stomach emptied at a very rapid rate indicating that the pylorus was held open by infiltration of the stomach wall. The patient was started on anti-syphilitic treatment and there was rapid improvement in all symptoms. He soon returned to work as a traveling salesman. September 1916 weighs 137 pounds and is free from stomach symptoms. Roentgen examination shows deformity only slightly changed. Wassermann remains four plus.

CASE 8 M A female age 23. Admitted September 1914. Married two years. No history of primary infection. For about one year the pa-

tient has suffered almost constantly from attacks of intense pain in the stomach usually relieved by vomiting. Weight 75 pounds—reduction of about one half former weight. Wassermann four plus—Wassermann on husband negative. Roentgen examination showed deformity of the pyloric half of stomach. This region apparently was infiltrated together with pyloric ring which was held open. This finding was corroborated one week later. October 8 1914 anti-luetic treatment begun and at the time of discharge from hospital (December 13 1914) the patient had gained 30 pounds in weight. All symptoms relieved. Roentgen examination February 1916 shows some improvement in deformity with stomach emptying at normal rate. November 20 1916 unable to report for examination as she has just been confined. Is free from all stomach symptoms and has gained 54 pounds in weight.

## COMPLETE BONY ANKYLOSIS OF THE JAW

### REPORT OF THREE CASES CURED BY OPERATION<sup>1</sup>

BY W. P. CARR, M.D. F.A.C.S. WASHINGTON

**A**LTHOUGH I have long been aware that bony ankylosis of the mandible sometimes occurs in parrots and rodents I had never heard of such an occurrence in a human being until about three years ago when I saw in consultation a child with congenital fusion of the alveolar processes of the upper and lower jaws. There was a history of two previous children of the same parents who died of starvation from the same cause.

I was therefore considerably surprised when I saw my first adult case an Italian, with complete bony ankylosis on both sides which had existed for 25 years and was the result of a fall on the chin when he was 12 years old. For five years there had been absolute immobility of the jaw. Previous to that there had been very slight motion but not enough to get food into his mouth except through a gap made by extracting two upper incisors. He had been in several hospitals in Europe and in this country but was told that nothing could be done. He was extremely anxious to be operated upon

and said he hoped I would either cure or kill him as he was tired of living in that condition. With this *carte blanche* permission I determined to attempt the operation though I was not then aware that such an operation had ever been done and was in complete ignorance of the splendid work our late lamented confrère Dr. Murphy had done for such cases. Accordingly I operated upon him at the Emergency Hospital July 26 1915 and the result was most gratifying both to me and to the patient. Now after 18 months he can separate his teeth an inch and a quarter says he can chew spaghetti and chew tobacco and is happy.

A few months later my second case came to me from having heard of the first. The condition was similar but roentgenograms showed it to be confined to one side. There had been complete immobility for 22 years also caused by a fall on the chin in childhood and the patient a very intelligent young man of 26 was rather skeptical as he told me he had twice been in the Johns Hopkins Hospital where unsuccessful attempts had been made

<sup>1</sup> Read at the meeting of the Southern Surgical and Gynecological Association, White Sulphur Springs, West Virginia, December 1916.

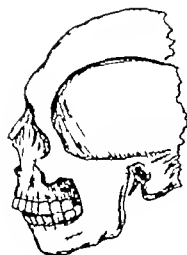


Fig. 1

Fig. 1. Notice the mouth completely open. The bone between dotted lines is the cut.

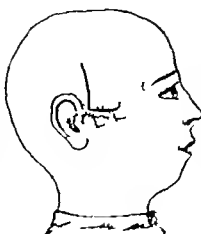


Fig. 2

Fig. 2. Showing the tongue found in the three cases.

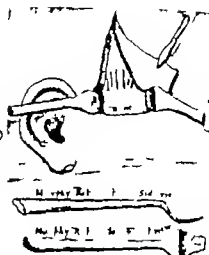


Fig. 3

Fig. 3. Face down, completed exposing bone and showing retractors in position. Below Murphy's retractor also in position.

to force the opening under anesthesia. I operated upon him in the Emergency Hospital February 20, 1916, and he is one of the most pleased and grateful patients I have ever had. He says one cannot imagine the relief it is just to get his tongue out between his teeth and to be able to eat as other people do. He gained 25 pounds in weight in a few months after the operation, and I was afraid for a while that he would do himself more harm by overeating than had been caused by the ankylosis.

The third case is a young lady who came to Dr. A. R. Shand with complete bony ankylosis of 18 years' duration caused by middle-ear disease.

On account of my experience with the two previous cases, Dr. Shand asked me to assist him in the operation, and I kindly gave me permission to report it in this paper. We operated upon her at the Emergency Hospital September 14, 1916. The result in this case has also been very gratifying though sufficient time has not elapsed to be sure the relief is permanent.

The operation which I improvised in my cases is in most respects similar to that perfected by Dr. Murphy and well described by Kreuscher in the *Interstate Medical Journal* for October, 1916. I am sorry I had not seen

it when I operated for Murphy's operation is an improvement on mine and his periosteotomy retractors are better than the instruments I used in a similar way. But I am glad that I was able to solve the problem for myself in a way that proved efficient. In my ignorance I have shown I think that it is not really necessary to interpose fat or fascia between the divided bone surfaces provided they are well separated and a rather pointed articular end cut on the ramus as shown in Fig. 1.

I did attempt to cover the cut surfaces of bone with periosteum but in only one of four operations upon the 3 patients was this really done in a manner at all satisfactory. And yet sufficient time has elapsed I think in the first two cases to show that the results will be permanent, especially as improvement is still going on.

The greatest difficulty in these cases was in overcoming the contraction of the masseter and internal pterygoid muscles. After section of the bones the jaws were still quite rigid until this muscular contraction was gradually overcome by the use of lead expansion screws and small dental jack screws placed between the molar teeth. This may have been due to the long duration of the ankylosis. The condition found in all three cases is very well

shown in Fig 2. There was absolutely no line of demarcation between the mandible zygoma and base of the skull and the bone was astonishingly thick and hard. The ramus of the jaw at the point of division was never less than half an inch thick and an inch and a quarter wide and in one instance was three fourths of an inch thick by  $1\frac{1}{2}$  inches in width and in all cases was hard as ivory with no cancellous tissue in the central portion.

In one case the internal maxillary artery was cut but the bleeding was controlled temporarily by packing with gauze until we had finished cutting away the bone as shown in the dotted line on Fig 1. I was then able to pass a catgut suture under the artery with a small curved needle and tie it. My most serious difficulty came from cutting the parotid gland. This accident occurred in 3 of the 4 operations although special care was taken to avoid it. Normally the parotid lies behind the ramus but in all these cases it overlapped the bone coming in the last case over the ramus as far as the midline of the bone. In each instance a small portion of it was cut off with the first incision.

The result was a salivary fistula which persisted for several weeks and although this did not affect the end result it caused considerable annoyance. There was no evidence of facial paralysis in any of my cases. Even in several patients where I have removed the whole parotid gland for tumor there has been only a slight and temporary paralysis of the face. It is difficult to understand this for the main trunk of the facial nerve usually divides in the substance of the gland into temporofacial and cervicofacial branches.

With Murphy's incision the danger of cutting into the parotid is lessened but care should still be taken to avoid it by keeping close to the bone in freeing it for division.

If I ever have occasion to perform this operation again I shall certainly use his method though I think I should make the transverse portion of the incision a half inch lower so that it will correspond to the lower instead of the upper border of the zygoma.

Murphy's periosteotome retractors are ideal for retracting and protecting the soft

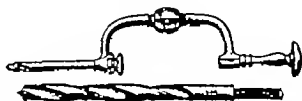


Fig 4. Carr's cranial bone drill or trephine is used for making an osteoplastic flap of the skull in brain surgery. By means of the drill several holes are made to be afterward connected by cutting away the intervening spaces with the rongeur forceps or a Gigli wire saw. The drill cuts a hole five-sixteenths inch in diameter very rapidly and safely. It is furnished with a guard by which the depth of the cut can be regulated, obviating all danger of cutting into the dura.

This instrument has several advantages over other instruments for opening the skull. It cuts more easily and quickly, requiring less pressure and force and cuts a clean hole just large enough to admit the rongeur forceps which is all that is needed. Three or four holes can be bored in a triangle or square and connected in a few minutes, or a large osteoplastic flap made in the same way.

tissues during division of the bone and as Kreuscher says are the key to safety and ease in doing the operation.

I am also of the opinion that Murphy's method of obtaining and interposing a flap of temporal fascia between the raw bone surfaces is an additional safeguard against failure provided it is protected from pressure by a wedge between the molar teeth of the affected side. While not absolutely necessary it may increase the range of motion and lessen the chances of recurrence of the ankylosis. I think it is very important that this flap should be protected from pressure as he has indicated.

I am decidedly opposed to the interposition of any extraneous substance whether of metal or animal membrane for while the operation may be successful in spite of such things they are useless and invite disaster. I agree entirely with Dr. Murphy that hand chisels and instruments are better than motor driven drills or saws for cutting the bone but I am opposed to the use of a hammer and chisel on any part of the skull and particularly in the neighborhood of the maxillary articulation and mastoid. I think I have seen severe and even fatal shock produced in this way. I found my cranial drill (see cut appended Fig 4) very useful for boring a row of holes across the bone, after which a small rongeur and gouge chisel used without

hammering easily completed the work. I have long ago given up hammering in mastoid operations and find this cranial drill extremely useful.

In conclusion I would say that this operation is not as easy and simple as it might seem at first sight. There are many important structures in the immediate neighborhood of the articulation among which are the facial nerve, facial internal maxillary and carotid vessels, parotid gland and Stenson's duct, and the depth, thickness and hardness of the bone will be a surprise to anyone doing it for the first time. Carefully done however it is safe and not really difficult and result really brilliant.

I know no operation which gives a greater relief and satisfaction to the patient.

Appended is a cut and description of the cranial drill I had made and the histories of the three cases referred to above.

**CASE 1.** I. E. male Italian age 37. Admitted to the Emergency Hospital July 26, 1915.

**Present history.** When about 12 years old the patient had a fall striking his chin and injuring his jaw. Since that time he has been unable to open his mouth or chew solid food. Until 5 years ago there has been very slight movement in the joint but he was able to eat only by putting food in through a gap where two incisor teeth had been removed and mashing it with his tongue against the roof of his mouth. But for the last 5 years there has been no motion at all in the jaw.

**Present condition.** Rather small man, fairly well nourished and normal in all respects except the absolute rigidity of the jaw and the retracted chin which always follows injury to the neck and head of the mandible. He is extremely anxious to have an operation done for his relief and says he would rather be killed than live in his present condition. Roentgenograms showed a massive bony ankylosis of both sides. Operation July 8, 1915.

A vertical incision was made a half inch in front of the auditory meatus extending from the upper border of the zygoma downward about an inch and a half. From the upper angle the incision was carried transversely across the cheek for an inch and a quarter. The bone was exposed, care being taken to avoid the parotid gland and Stenson's duct. It was impossible to find any line of demarcation between the ramus and the zygoma, base of the skull. The ramus was an inch and half wide and was finally exposed low enough that I was able to find a free edge anteriorly and posteriorly. A flexible retractor was then inserted under the ramus and it was cut away with gouge chisels with the hammering, and pointed at the articular side somewhat like the

normal head and neck. A flap of periosteum was turned down from the zygoma and inserted between the cut bone surfaces. The same operation was then done on the other side but a piece of the parotid gland was cut off and the internal maxillary artery wounded by a slight slip of the chisel. Bleeding was controlled temporarily by gauze packing and after the bone had been cut away the artery was tied by passing catgut in a small curved needle under it. The periosteum was so thin over the zygoma that no satisfactory flap could be obtained. The wounds were closed and the jaw found slightly movable but still quite rigid on account of muscular contraction. Attempting to pry open the teeth resulted in knocking out three or four before it was found that they were extremely loose from disuse and shelled off as easily as grains of corn from a cob. Finally a mouth gag was placed in between two moderately firm molars and an inch cork put in between the jaws in front.

The next day this cork was removed and it was found that the patient could open and close his jaw to the extent of about a half an inch. Later by the use of gradual dilatation with ordinary lead expansion screws such as are used by carpenters, the range of motion was increased to one inch and when last seen 16 months after operation the range was one and a fourth inches.

Cutting the parotid gland caused a salivary fistula on one side which did not completely heal for weeks, otherwise convalescence was normal and the scars when last seen, were hardly noticeable.

**CASE 2.** D. D. white male single age 32. Admitted to the Emergency Hospital on February 1, 1916.

**Present history.** When about 10 years old, the patient fell from a cherry tree striking on his chin. After recovery from the acute injury the jaw was very stiff and sore and this rigidity increased until he was unable to eat solid food. A year or so later he was taken to a hospital where the jaw was opened forcibly under an anesthetic. This gave temporary relief but in a few months the condition was worse than before. Several years later he was again taken to the same hospital and another attempt made to break up the ankylosis by forcible dilatation under ether. This time the attempt was not successful and several teeth were knocked out in the attempt to pry open the jaw.

After that there was complete immobility. As in the previous case food was introduced through a space left by the loss of an incisor tooth and masticating with the tongue.

**Condition on admission.** Tall, slender very intelligent young man with the usual receding chin and complete immobility of the jaw. He was pale, not very well nourished, and very sensitive about his condition. An excellent series of roentgenograms was made by Dr. Thomas A. Croover showing the usual bony mass about the mandibular articulation on the right side but the left articulation seemed nearly normal. The chin was drawn

slightly toward the affected side and the cheek on that side was fuller and more rounded. This corresponds to Dr. Murphy's observation that the best looking side is the affected one in unilateral cases. This is due to the shortening of the ramus at the point of fracture or disease and the inhibited development of the bone that results. The patient had several badly decayed teeth but had never had toothache.

Operation an hour after admission, February 12 was similar in all respects to that described in Case 1 except that it was done on the right side only and without accident of any kind except cutting off a small piece of the parotid. The operation was much facilitated by passing the curved handle of a bone forceps behind the ramus first on one side and then on the other and boring out the bone with my cranial drill. No flap was interposed but the articulating end of the ramus was cut to a rounding point. After section of the right side the jaw was found movable and pried open about an inch very carefully with a pair of Goodell uterine dilators, one on either side between the molar teeth. This was done to stretch the muscles which were much contracted.

*After-treatment* There was no special after-treatment for a week. Then I turned the patient over to my dentist Dr. A. B. Cooper who gave him the expansion screws and later small dental jack screws and taught him how to use them himself, and how to tighten them up a little more each day as the muscles relaxed. He wore them mainly at night, with a silk thread attached to prevent swallowing them during sleep. At the end of three weeks he could open and close his mouth without discomfort, almost to a normal degree. The range of motion is now an inch and a quarter and the patient has a new set of teeth. The wound healed readily except for a small salivary fistula which persisted for 6 weeks but did not necessitate confinement. The patient sat up on the third day and was comfortable and was discharged from the hospital on the tenth day after operation. He is now well eating without difficulty and about the most pleased patient I have ever had.

**CASE 3** Miss D. J. female white age 22 single Patient of Dr. A. R. Shands. Admitted to the Emergency Hospital September 14 1916

*Previous history* The patient had had an acute suppurative of middle ear following measles when four years old. The ear drum burst and drained for some weeks and was followed by soreness and stiffness of the jaw which finally became fixed and has remained so for 18 years.

*Condition on admission* A very intelligent young lady of medium size well nourished but with soft muscles. No teeth had been lost but the lower jaw was so much retracted that the lower incisors were half an inch back of the upper incisors leaving a gap through which food was introduced. Jaw absolutely rigid. Chin drawn slightly to right side and right cheek fuller than left. Roentgenograms made by Dr. Groover showed heavy mass of bone about right mandibular articulation and left joint apparently normal.

Operation September 15 by Dr. Shands with my assistance. Dr. Shands attempted to operate through a straight transverse incision over the zygoma but was obliged to make an L running down a half inch in front of the ear in order to get sufficient room. The bone was cut as in the previous cases with cranial drill and gouge chisel, without hammering and trimmed with bone forceps. Immediately on section of the bone there was a wide separation and the mouth opened easily an inch and a half. A small piece of parotid gland was cut off in spite of our care to avoid it. No flap was used between the cut bone surfaces.

*After-treatment* No special after-treatment was used. The muscles were not contracted as in the previous cases and the young lady was able to eat in a few days without discomfort. The wound healed readily except for a small salivary fistula which had almost entirely healed when she returned to her home in North Carolina in November 1916.

I advised Dr. Shands to teach her to use the expansion screws and have her use them on the slightest sign of recurrence but so far it has not been considered necessary.

## RECURRENCE OF GALL-STONES<sup>1</sup>

By JOHN B. DEAVER, M.D., F.A.C.S. PHILADELPHIA

EVERY experienced surgeon finds himself confronted with the question of recurrence of symptoms requiring secondary intervention after operation for the relief of gall bladder or biliary conditions. As in other questions perhaps a free exchange of views may help toward the solution of this vexed problem.

About 4 or 7 per cent of the cases of biliary affections operated on by me at the German Hospital of Philadelphia were secondary cases i.e. such as had had one or two or even more previous operations performed by me or by other surgeons for gall stones or other disorders of the bile passages in periods varying from seven months to seventeen years of



these the greater number (60 per cent) required re-operation within one year after the primary intervention

In a recent publication I have presented the results of a study of 1031 operations performed by me from January 1910 to January 1916 with a mortality of 7.18 per cent, including 42 recurrent cases in the series. More recent figures (January 1916 to November 1, 1916) give about the same percentage of recurrent cases but a somewhat higher percentage of operative deaths. In 152 operations there were 15 deaths and 8 patients who had had one or two (one case) previous operations for gall bladder disease. The patient having a history of two previous operations was also the one who had had the longest interval between operations—the first a cholecystostomy having been done seventeen years and the second a cholecystoduodenostomy fifteen years before the present operation.

#### 1916 GALL BLADDER OPERATIONS

	Number of operations	Deaths
Number of operations	5	5
Number of recurrences	8	1
Type of operation	Number	Deaths
Cholecystectomy	93	4
Cholecystectomy and choledochostomy	3	6
Cholecystostomy	20	3
Cholecystostomy and choledochostomy		
Cholecystostomy, choledochostomy, and pancreatostomy		
Choledochostomy	4	
Cholecystoduodenostomy		
Total	141	15
Recurrences after primary cholecystectomy		
Causes		
Stones in gall-bladder		
Stone or stones in common duct		
Adhesions	4	
Dilated common duct		
Total	8	

In addition to the 1183 operations referred to above and all of which were done in my clinic at the German hospital there were 642 in this clinic prior to 1910 making a total of 1825 operations on the biliary passages. My total number of operations is considerably more than this as I have not included those done in former services at St. Agnes, St. Mary's, and the Philadelphia hospitals and

during the last five years service at the University Hospital.

The most common cause of recurrence after cholecystostomy in the combined series was stone or stones in the gall bladder (12 cases). Next in frequency were adhesions (8 cases) and stone or stones in the common duct (6 cases). In the earlier series four of the patients required re-operation after a cholecystectomy, two for stricture of the pancreatic portion of the common duct or the duodenal orifice and one each for stone in the common duct and postoperative duodenal fistula. All the recurrent cases in the latter series resulted after primary cholecystostomy. This would make it appear that cholecystectomy, though the more serious operation, reduces the risk of future troubles. As I have stated elsewhere, however, under good conditions the mortality figures of the two operations do not greatly differ.

The failure to remove all the gall stones at the primary operation is the most potent cause of recurrence of symptoms. This adds emphasis to the arguments we surgeons are continually bringing forth of the importance of early operation. Kehr, perhaps the greatest German authority on surgery of the gall bladder, does not hesitate to lay much of the blame for recurrent gall stones on the medical man. He points out that in long standing cases, the gall-ducts become dilated and stones are apt to lodge in the recesses so that they cannot always be removed or even detected at operation and thus give rise to renewed attacks of cholelithiasis. Operation, says Kehr, in cases in which inflammation is limited to the gall bladder may be postponed for a few weeks or months but in cholangitis it should be resorted to after a second attack before the ducts have had a chance to dilate. There are of course operators, he says, who fairly court recurrence by their method of operation, but the surgeon who gets a chance to do an early cholecystectomy and drains the widely incised choledochus is only rarely confronted with a recurrent case. In the matter of free and prolonged drainage of the biliary tract I heartily agree with Kehr. I regard it as the best means of overcoming recurrence and I make it a practice to use large sized

tubes and allow them to remain *in situ* until they practically drop out

It is not always easy to determine whether these recurrent stones were overlooked at operation or whether they had actually formed again after operation. The impression however is strong that in a few instances at least re-formation had taken place inasmuch as the number of stones in some of the cases ranged from five or six to several hundred which could hardly have escaped detection. On the other hand it is not always possible to clear the two primary branches of the hepatic duct. Again as in the attempt to remove a stone or stones from the hepatic duct one or more may be displaced upward beyond the reach of the surgeon and thus later produce common-duct obstruction which requires re-operation. I have had cases in which I have removed muddy granular material from the gall bladder and have been obliged at a later date to operate for obstruction of the common duct. I have also seen cases which required several operations before a permanent cure was established. These were cases of cholangitis or better perhaps cholangiolitis. Here, also complete and prolonged drainage is essential for a cure and we should not hesitate to open the common or the hepatic duct to secure it.

I would like to call attention to the advantage of the T tube in cases where prolonged drainage of the common duct is necessary. I have found it especially valuable in chronic cholangitis and in cases complicated by a more or less marked pancreatitis. This arrangement can be likened to an artificial gall bladder of infinite distensibility and while it is in place it is impossible for the bile to be retained in the bile-ducts and stagnate under tension. The tube may be allowed to remain for any length of time that is desired and until one is assured that the biliary tract has thrown off the infective process. These tubes should be carefully constructed. I have recently had a case of cholecystitis with pancreatitis in which I removed the gall bladder and instituted drainage through a T tube. Drainage was never free and finally in about two weeks stopped entirely. All efforts to clear the tube by suction and introducing fluid

were unavailing. On removing the tube was found that at the junction of the two arms of the tube the lumen had been almost obliterated by a diaphragm of rubbery sandy deposit had completed the obstruction. Since removing the tube the patient has been free of symptoms suggesting those for which he was operated upon and in the absence of his gall bladder are undoubtedly due to the pancreatic lesion. This observation also supports the undoubted efficacy of biliary drainage in the cure of chronic pancreatitis.

Frequently associated with numerous minute stones in the common, the hepatic, and the smaller bile-ducts with occlusion of the papilla of Vater is biliary cirrhosis. This condition I have frequently met with and have found that only prolonged gall bladder or common-duct drainage will suffice to bring about a permanent improvement or cure. That cases of this type can be given as good a chance for improvement or cure by medical treatment, including that given at the various famous springs to my mind is preposterous. Anyone who has seen and studied the operative findings cannot but agree with me as *stated* in this statement. It is only the medical man who has seen in a half sort of way on such a case that may not be convinced. This reminds me of a remark made by the late Dr. McBurney in discussing a paper on appendicitis when he said "Lord deliver me from the man who has had a case. Those of my onlookers who have seen me upon many occasions delve into the primary hepatic ducts and scoop out muddy sand laden material have with me concluded that recurrence would surely occur. How any medicine could clear the bile ducts of this material I cannot see yet these cases are frequently subjected to prolonged medical treatment."

It is well known that the chronic affection beget gall stones while the acute infection cause destructive lesions. Chronic cholangitis must be reckoned with in the study of the causes of recurrence of symptoms. The following case will illustrate this point.

Mrs. — aged 45 years. Recurring attacks of biliary colic with jaundice covering a period of one year during which time she was treated medically

When I was asked to see the patient I found her feverish with accelerated pulse profoundly jaundiced, suffering constant pain, with enlarged liver and a painful and palpable gall-bladder. I advised immediate operation which showed an inflamed gall bladder distended with stones, with common and hepatic ducts filled with stones. The gall-bladder was removed, the common duct opened and fifteen stones removed from the common and the hepatic ducts. With a small scoop many very small stones were removed from the primary hepatic ducts. The papilla of Vater was structured necessitating dilatation with graduated probes. The common duct was drained. Culture of bile showed colon bacillus. The patient made a stormy recovery. The drainage was removed in eight weeks. She remained well for one year when she was again the subject of practically the same symptoms as before operation.

The second operation showed numerous small stones in the common and hepatic ducts. Again the ducts were cleared as well as could be done and common duct drainage made. Again the patient recovered, remaining well for a little over a year when she suffered from an attack of cholangitis that has improved but has not entirely cleared up. It is too plain what the future of this patient will be. I have advised further operation and drainage of the common duct for an indefinite period.

I have one patient wearing a T tube now going on three years who is perfectly well and will not listen to removal of the tube having had two previous operations. I have a number of patients wearing these tubes upon whom I have made the second or third operation. All of the patients are doing their work as they did before being attacked. The majority of the patients are poor women, housewives and able to attend to their household duties. In this class of cases where the cystic duct is patulous and the gall bladder can be left I consider drainage by way of the gall bladder the best and safest method.

I cite these cases as one of the several causes of gall stone formation. Minute stones imbedded in the mucosa of the gall bladder can only be removed by taking out the gall bladder. This may be unfortunate from the standpoint of the future of the patient in the event that obstruction of the common duct should occur.

Other cases in the series showed renewed exacerbations of infection of the gall bladder or the ducts through failure of the operation to remove all the infection as indicated by the presence of acute or chronic cholecystitis

chronic cholangitis and pancreatitis at the subsequent intervention. Some of the less common causes of recurrence of symptoms were obstruction of the papilla of Vater, biliary fistula, internal and external and interstitial pancreatitis and pancreatic lymphangitis.

The rôle of adhesions in producing persistent or recurrent symptoms after operation upon the biliary tract is difficult to solve. It is my experience that adhesions of greater or less extent are formed after all such operations without exception. Without doubt many minor discomforts can be attributed to this cause. As this series shows however it is rare for adhesions *per se* to give symptoms of sufficient severity to warrant operation. Practically all recurrences of any moment barring gall stones which are left in the primary operation and cannot truly be considered as recurrences, are due to recrudescence or renewal of infection either in the biliary tract or in the most closely related organ, the pancreas. In the absence of infection or mechanical obstruction the great majority of adhesions are benign. Still it must be admitted that adhesions are undesirable sequelae of operation and are at times productive of symptom that are more or less serious. We should bear this in mind in operating. There is no preventive of adhesions. The various fluids and membranes that have been recommended for this purpose have all been disappointing and often have actually aided the very process they were intended to inhibit. Much may be done however by limiting the trauma to endothelial surfaces at operation and dispensing so far as is consistent with safety with drainage tubes or gauze. In fact, I never use gauze drainage in this type of surgery. The gall bladder fossa may be over sewed and brought together accurately by a running knotted suture so that this raw surface will invite few adhesions or none. Rough sponging should be avoided and the dissemination of bile, blood, or infected fluids carefully prevented. With these precautions the rôle of adhesions in postoperative troubles will be small and of little practical moment.

In considering the causes of recurrence of gall stones we must necessarily revert to the

primary causes of gall stone formation. Al though Aschoff and Baumeister believe that they have demonstrated the aseptic formation of the radial cholesterol stones in the gall bladder they at the same time show that all other gall stones the complex ones and the cholesterol pigmented calcium stones owe their origin to infection and obstruction. To my mind every gall stone is in the words of Moynihan a tombstone erected to the memory of the bacterium which lies dead within and is what our lamented colleague John B. Murphy called an infection sequence. Murphy further stated that the cholesterol which forms 98 per cent of all gall stones is the product of dead epithelial cells lining the gall bladder and the stones by their presence in a more or less infected zone cause a continual deposit of cholesterol which thus continually increases the number of stones.

until finally there is the arrest of a micro-organism of a more virulent type which starts suppuration in the gall bladder. This agrees entirely with the autopsy in which finally is the strongest argument. The internist and the gastro-enterologist form their conclusions from the outside plus laboratory findings which makes their results more or less uncertain. Were it not for the thickness of the abdominal wall between their eyes and the lesion they would be as wise as the surgeon. The infection when distributed over a great area of mucous surface will result in a large number of gall stones for as ye sow so shall ye reap.

We all know that infection is carried to the gall bladder in various ways through the portal circulation, the common duct, the lymphatics the systemic circulation and by juxtaposition. The selective action of certain virulent bacteria from a distant focus for the appendix, has been brilliantly demonstrated by Rosenow. My experience extending over a number of years and comprising practically twelve hundred cases in the last six years for affections of the biliary passages convinces me that the appendix, in turn is the focus of infection for nearly all upper abdominal diseases the gall bladder affections gastric and duodenal ulcer pancreatitis etc. It is hardly necessary for me to dwell upon the importance

of early removal of even a slightly trouble some appendix in order to avoid future trouble. Nor before a body of this kind need I do more than point out that the destructive possibilities of appendiceal infection have no limitations and this may practically be said of infection of the bile passages. From the confusion still reigning with regard to the etiology of malignancy we are able to gather at least this that carcinoma is the result of irritation. Ergo remove the irritation. The fact, also that 85 to 95 per cent of primary carcinomata and only 15 to 16 per cent of secondary carcinomata of the gall bladder are associated with gall stones indicates that gall stones are the cause and not the result of carcinomatous degeneration (Kehr) and is another argument that speaks for itself. The further pernicious results of neglected gall stones are seen in myocarditis and kidney degeneration the two most important factors in my mind in the postoperative prognosis of these cases as well as in degeneration of the blood vessels diabetes hæmatogenous infection, etc.

Whether we can avoid the formation and the recurrence of gall stones by a cholesterol free diet as recently suggested by our friend Gerster remains to be seen. As for the practice of sending this class of patients to the various springs for treatment -- this appears to me very much like the repentant attitude of the young woman about to undergo an operation. Before being taken to the etherizing room she turned to her husband saying "My dear if I have done anything to vex and offend you and I know I have I want you to forgive me and in the next breath she added but if I come out of this all right I'll do it again I promise you. These patients may come out of their troubles all right for a while but they're sure to have it again sooner or later.

Disease of the biliary passages is essentially surgical and not medical and the most common preventable cause of recurrences is late operation. Until this fact has impressed itself indelibly on the physician as well as on the layman we cannot expect to improve our percentage of complete cures of gall bladder and associated diseases.

AMERICA'S PLACE IN THE SURGERY OF THE WORLD<sup>1</sup>

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WHEN searching for a subject for this evening many themes presented themselves to me but one important topic has stood out conspicuously—the relation of American surgery to that of other nations. Consequently I shall take as my topic America's Place in the Surgery of the World.

That we may appreciate adequately the advances in surgery it is necessary for us to look back at the conditions that existed as recently as only fifty years ago. At that time although many operations were performed in hospitals the well-to-do shuddered at the thought of being taken to an institution and were cared for at home. The poor went to the hospital but mostly against their will.

When a patient entered the hospital he was looked after in some institutions by male attendants, in others by women who although they did their best were little more than helpers. In no hospitals were there any trained nurses to be found.

The hospital internes were too few in number adequately to look after the patients coming under their care. When the patient was ready for operation he was usually carried to a large amphitheatre where the operation was undertaken. Some operators would appear in full dress suits or in long black coats. The sleeves of these coats had been ingeniously slit up at the sides so that the surgeon could readily fold them back until his arms were freed to the elbows. The assistants, who were frequently medical students at the beginning of the school year knew little about the individual instruments or their uses but to them was entrusted the selection of the necessary implements and the arrangement of them for the operation. Even with these primitive surroundings the patient was infinitely better off than his fellow of fifty years before because in the meantime anesthetics had been discovered. He was put to sleep and the operator who had usually in the meantime washed his

hands commenced the operation. The giving of the anæsthetic was generally entrusted to some one who had had very little experience in its administration consequently untoward symptoms frequently interrupted the progress of the operation. Some surgeons would think nothing of putting their hands into the wound and then after handling the sheets or blankets around the patient of placidly continuing the operation. What need of worry? They were totally ignorant of the possibility of contamination. Even since my graduation I have heard a surgeon specifically warn his students against the dangers of contaminating the clean wound. He would then wash up carefully and while admonishing his students, would walk around the amphitheatre with his hands in his pockets. The next minute these hands went directly from his pockets into the wound. Needless to say this surgeon, although he had a partial theoretical knowledge of bacteriology had absolutely no conception of its practical application. I have seen another surgeon of excellent repute place the handle of his knife in his mouth for safe keeping while he was busy tying ligatures.

The operations in those days were limited in large measure to lesions on the surface of the body and to pathological conditions of the extremities requiring surgical interference. The opening of the abdomen or of the chest cavity was a rare occurrence. The after treatment of the surgical cases fell mainly upon the surgeon or the interne because the female attendant in many instances did not have the necessary knowledge.

Most of the private patients were operated upon in their own homes. Just imagine a member of this association as a routine procedure getting up early in the morning to gather his instruments together communicating with two or three of his medical friends (not by telephone) and then repairing to the patient's home to arrange for the operation. The surgeon of course, looks after all the details minor as well as major himself. He

is thoroughly tired out before he commences the operation. The operation itself is rendered long and tedious by the poor anesthesia and possibly because the surgeon has inadvertently left at home some instrument very necessary to the successful handling of the case. The operation over he or one of his assistants has to remain with the patient all night.

You and I often think that we are hard pressed but the average surgeon of fifty years ago would have felt that he was literally in clover if he had been surrounded by the safeguards and assistance that we take as a matter of course at the present day.

#### THE SURGERY OF TODAY

Today the telephone rings the family physician a most competent man tells you that Mr. — has a clear cut case of appendicitis. The patient at once voluntarily suggests that he be taken to the hospital. You ring up the hospital and arrange for the time of operation. When you get there the patient's history has already been carefully taken the urine examined and a blood-count made. You examine the patient, confirm the diagnosis, change your clothes, wash up and proceed to the operating table. The patient in the meantime has been carefully cleaned up, has been anesthetized by an expert, and you at once begin the operation. Every instrument that may make your work easy is at hand and you have an ample corps of competent assistants and nurses. The operation over the patient is under the constant supervision of a nurse and is visited frequently by the house man. If the convalescence is normal you probably see him once a day or every other day. We talk about the improvements in rapid transit in electricity and in business methods but none of these can compare with the great strides made in the handling of surgical patients.

Many factors have been contributory to this wonderful advance in surgery notably the development of asepsis due to the fundamental labors of Pasteur and of Lister and to the knowledge obtained as a result of years of experience. I shall not give a detailed description of the many improvements in the

methods of operating or enumerate the many diseases that have year by year been transferred from medicine to surgery nor shall I indicate to you the steady advance made where in the past nothing was thought possible. Read *The History and Development of Surgery During the Past Century* a charming address delivered by Dr. Frederic S. Dennis of New York before the International Congress of Arts and Sciences at St. Louis in September 1904.<sup>1</sup> It is brimful of information and after reading it one has a feeling of pride in realizing that America has played such a prominent rôle in the phenomenal advance of the surgery of the world during the last fifty years. With the surgical achievements since 1904 you are all thoroughly familiar. I wish here to refer chiefly to the large debt we owe to hospital authorities and to the trained nurse.

*The hospital.* Do we realize the stupendous sum invested in hospitals in the United States? Recently I asked one of the foremost hospital experts in the country to tell me approximately how much money was invested in hospitals, sanitaria and institutions for the care of the insane. He said that the sum was enormous and probably amounted to three billions of dollars. Be this as it may most of us have gone along complacently completely engrossed in the small institutions with which we are connected, little realizing that thousands of others have been doing just as much for the improvement of the care of the sick.

Most institutions have had small beginnings. With their gradual development and increased responsibilities it was realized by the larger institutions that they needed men of affairs men with a broad vision on their boards of trustees. Thus at the present time the leading hospitals of the country number among their trustees some of the best known and most farseeing men.

Inseparably linked with the molding and the development of the hospitals of the United States is the name of that Dean of American Hospital Superintendents Dr. Henry M. Hurd, for a quarter of a century superintendent of the Johns Hopkins Hospital, a man of rare judgment and tact a man who for years

has done yeoman service in promoting the betterment of hospitals

The superintendent of the small hospital of today is usually a trained nurse who not only guides the nurses training-school but also takes care of the executive duties of the hospital. The larger institutions, as you all know usually have a medical man as the superintendent. The larger the hospital becomes and the more manifold its activities, the more necessary is it to have an executive, who in addition to his innate tact level headedness and medical knowledge must be a thorough master of detail and an able organizer just such a man who could equally well handle a large business establishment or a railroad. A medical man so equipped is difficult to find. Fortunately this paucity of ideal hospital superintendents will not always exist. The need has been fully realized. In the hospital with which I am connected there are three assistant superintendents. These men are not only of great assistance to the superintendent and to the hospital, but are themselves developing into first class executives, and after a few years will undoubtedly have charge of other hospitals. This method of training hospital executives is growing in vogue and if all the leading hospitals pursued this same method the supply of competent hospital executives would keep up with the demand.

You and I profit greatly by meeting with one another and exchanging ideas just as we are doing at this annual meeting. Hospital superintendents assistant superintendents and superintendents of nurses have likewise realized the value of such meetings and some years ago formed the American Hospital Association. They very wisely also included in their membership hospital trustees and physicians and surgeons particularly interested in hospital management. I would strongly urge each and all of you as soon as you reach home, to find out if the superintendent and the superintendent of nurses in the hospital or hospitals with which you are connected are members of the American Hospital Association. If not, communicate with your hospital trustees impress upon them the loss that your hospital is sustaining through their

lack of membership and tell them that it is the duty of the hospital not only to see that their executive officers become members but that they go as the official representative of the hospital all expenses being defrayed by the hospital board.

We can profitably spend a moment in considering the program of the eighteenth annual conference of the American Hospital Association which was presided over by Dr Winford H. Smith, and which was held in Philadelphia two months ago. Among the many interesting subjects discussed were: What dispensary work should stand for Clinics for venereal disease why we need them how to develop them. Industrial accident cases in dispensaries should they be accepted? How shall the finances be managed? New features in dispensary work. Report of the committee on hospital construction. The hospital dietary. The so-called diphtheria epidemics in general hospitals preventive measures. Autopsies methods of obtaining them and measures for protecting the hospital.

Many other interesting and important topics were considered and then there were round-table sessions for the large hospitals and also for the smaller hospitals. At these sessions hospital superintendents compared notes told of their difficulties, and asked how these could be best overcome. These sessions are invaluable. The best brains of the large and small hospitals are gathered together and problems that have worried a member of the association can often be quickly and easily solved by another member who has in the past successfully dealt with a similar condition.

At these round table sessions San Francisco and New York Texas and Canada New Orleans and Minnesota in fact all parts of North America are gathered together and compare notes each imparting to the other something that is new and valuable.

Every hospital that is trying to do first class work should send at least one or two representatives to the American Hospital Association. Those of you who are living in the smaller localities know how difficult it is to get satisfactory plans for new hospitals

and even when the buildings are completed you are often chagrined to find that many essentials have been overlooked. The American Hospital Association has for several years had under contemplation the establishment of a central bureau where the duplicate plans of all existing and contemplated hospitals both large and small, could be kept. The value of this is at once evident. When a board of trustees decide to build a new hospital they will immediately consult this collection of plans. Knowing the cost of each they will pick out the five or six that appeal to them most and can then visit these half dozen institutions instead of being compelled to go throughout the country before discovering the exact type of institution needed. This plan of the Association will undoubtedly be so broadened that it will also include the latest in hospital furnishing the best methods of executive management of hospitals and also the operating tables instruments and complete equipment for the operating room.

When this hope of the Association is realized one will not only be able to get with the minimal amount of labor the best hospital plans but will also be guided in the purchase of the entire hospital equipment. This will bring about an enormous saving not only in the initial hospital expense but in the subsequent purchase of supplies.

The hospital superintendents of the United States are in thorough sympathy with the great advances in medicine and surgery and are a most important factor in the development of both. It is the co-operation on the part of the superintendent, the superintendent of nurses the operating room nurses the ward nurses and the assistants that enable the surgeon to do the maximal amount of good.

*The trained nurse* If the Crimean war had done nothing more than develop a Florence Nightingale it would have been well worth the sacrifice of so many brave men on both sides in that bloody war.

We in surgery rely largely on asepsis for our success. Asepsis for dressings instruments and for everything coming in contact with the patient depends upon the operating room nurse. Has it ever occurred to you

how seldom this trust is misplaced? Is there one of us who if put to the test would show such an unfailing response to our duty? Surgeons make mistakes assistants are not infallible, but in a first class operating room a failure on the part of the nurse is almost unknown although her duties are as important as, if not more important than those of the surgeon and his assistants.

The after-care of the patients is entrusted almost entirely to the ward nurse. Here also we find a fidelity that cannot be excelled in any other walk of life. Were it not for her constant vigil many of our successes would be written as failures. In the summing up of the brilliant advances in surgery the achievements of the trained nurse stand side by side with those of the surgeon. In no other country is the standard of nursing as high as it is in America. The splendid work done by the American nurse is in part due to her excellent preliminary education in part to careful and extended training in large measure to the fact that she knows her labors are thoroughly appreciated and lastly to the fact that after graduation she is an independent member of society and of a recognized profession. Do you realize that the American Nurses Association has an army of thirty thousand members and that seven thousand of these are enrolled in the American Red Cross?

#### THE ASSIMILATION OF SURGICAL KNOWLEDGE

Many medical societies have good working libraries and I am glad to see that these are increasing in number. Connected with the medical schools one also finds aggregations of splendid books. Among the larger libraries are those of the College of Physicians of Philadelphia the Boston Medical Library and the John Crerar Library of Chicago. The greatest medical library in the world however is the Surgeon General's Library in Washington. In it are to be found every medical journal published complete sets of the old journals of nearly every country all the newer medical books and most of the older ones—it is a storehouse of old and priceless volumes. A library to be of value must have a good index. The index catalog the real monument of that far seeing genius the



late John S. Billings, contains the titles of nearly all that has been published in medicine. Let us go to the library for a few moments. We want to look up a certain subject. A glance through the catalog will give us the literature on the subject up to a certain date. The *Index Medicus* is then examined and the references up to the last few months are found there. The index cards are then furnished and in the short space of half an hour we have references to all that has been written on the subject up to the previous month. This list is given to the librarian and behold the originals of practically all of these are around you on the table in twenty minutes. I say practically all because in nearly every instance not a single book is missing. Such a feat can rarely be duplicated in any other library. One is frequently able to accomplish more in this library in a day than would be possible in another library in two or three days.

Personally I am under lasting obligation to the library authorities for the unflinching courtesy and continual help they have given me during the last twenty years. This library is the gem of American medicine. Some of you may be unaware of the fact that books from the library may be sent to you direct or be gotten through your own medical library.

#### THE DISSEMINATION OF SURGICAL KNOWLEDGE

Naturally from time to time surgeons wish to enlighten their confrères concerning some rare case that has come under their care or to publish an analysis of their findings in a certain group of cases. We have in this country ample means of disseminating this knowledge. Nowhere in the world is there another medical journal that has such a large circulation as the *Journal of the American Medical Association*. The success of this journal has in large measure been due to the able editor Dr. George H. Simmons. Any article published in the official organ of the American Medical Association is soon known the world over. I have watched with the greatest pleasure the steady rise in the number of subscribers of the *Journal* from about nine thousand in 1899 when Dr. Simmons became editor to sixty-eight thousand at the present time.

Two surgical journals stand out prominently. The *Annals of Surgery* under the editorship of Dr. Lewis S. Pilcher has stood the test for years and has been the means of adding greatly to the prestige of American surgery. *SURGERY GYNECOLOGY AND OBSTETRICS* founded and edited by Dr. Franklin H. Martin is a proof of what can be accomplished. The splendid reproductions of its illustrations and the abstracts of the newer and more important surgical articles from all countries enable the busy surgeon to keep well abreast of the times.

These three journals with several others that I might mention give the American surgeon splendid avenues for putting before the medical world anything that he has accomplished.

#### WHEREIN WE MAY IMPROVE OUR SURGERY

It has often been said that our profession contains many half-baked surgeons and the charge is perfectly true. One might excuse an inexperienced mechanic for attempting to repair the mechanism of an expensive limousine. If he perchance does much damage this can be remedied by a good mechanic, or at worst the injured parts can be duplicated. The novice is given an old or practically worthless machine to experiment with. When it comes to surgery the well-to-do patient usually employs the most expert surgeon he can find. The majority of the poor and incapacitated also come under the care of the experienced surgeon, but some fall into the hands of men who are by no means capable of dealing with intricate surgical cases. These physical wrecks are just as dear to their families as are those who live in affluence—often more so—and it is our duty to see that the maximal number of them are saved. Machines can be duplicated; human lives never!

How can we eliminate the evil? In the first place by putting a premium on careful conscientious work, and in the second place by adequately training the coming generation. Most of these unbaked surgeons are essentially good men; they mean no wrong and their only fault is a lack of the requisite training. A few I am sorry to say are essentially

commercial and seem to have little appreciation of the value of human life. They see a surgeon remove an appendix with the utmost ease and think that they can do it just as well little realizing that it is the long years of training of the operator coupled with the excellent operating facilities that enable the expert to perform the operation so satisfactorily. The inefficient operator also fails to realize that a complicated appendix operation may be one of the most difficult in surgery.

Many of us have realized that this state of affairs should not exist but have not had the courage to act or did not realize how the condition could be remedied. It was Dr. Franklin H. Martin of Chicago who not only suggested a remedy but took action. The College of Surgeons is the result. Some surgeons looked on with skepticism but I think all will now agree that the College will be the most effectual means of controlling the unwarranted operating by inexperienced men. In such a vast undertaking some mistakes are bound to occur. Some thoroughly capable men have doubtless been kept out and a few black sheep admitted but the sum total has been a tremendous advance in the right direction. A premium on good work has been established and those men who have not measured up to the requirements will bestir themselves to get the necessary training which will enable them to gain membership in the College for sooner or later no man who is unable to gain admission to the American College of Surgeons will be considered eligible for the surgical staff of any self-respecting American hospital. Too much credit can not be accorded Dr. Martin in whose mind this plan originated and to Dr. John M. T. Finney, the first President of the College. Dr. Albert J. Ochsner and others for the great amount of time and labor they have devoted to this remarkable advance in American surgery.

There are a few matters in connection with our own work that I may now mention.

*Promptness* in the operating room is a very important factor. Of course I realize that where the surgeon operates in several hospitals his operations in the first hospital may be more complicated than he had any idea of

and may consume far more time than had been anticipated thus rendering him late at his second hospital. But there is nothing that so demoralizes an operating room staff as the continual lateness of the operator and there is usually little excuse for his being late for the first operation of the day. This may seem to be a very trivial point nevertheless it has a very important influence on the day's work. Another matter that some of us pass over lightly is keeping the family physician posted as to the condition of his patient. He has frequently watched the case carefully for weeks and after due time has prevailed upon the patient to come under our care for operation. It is really incumbent on us not only to inform him fully as to just what was done at the operation but also to report the patient's progress. Looking at it from an entirely selfish standpoint this is a wise procedure, because in subsequent months or years we may want to find out from him just how the patient has progressed.

If you or I go to the head of a prominent business house or to a railroad president and ask for any important information concerning the business or the railroad we can usually obtain the desired information at once. Our work also should be thoroughly systematized. Careful histories, operation notes and laboratory findings are of course recorded in all good modern hospitals. These cases should be carefully analyzed at frequent intervals to find out what have been the immediate results. Furthermore we should have a definite follow-up system to see what benefit the patient has derived from the operation. Probably the most indefatigable follower up of old patients is my friend Joseph C. Bloodgood. His studies on the after results in the hernia cases and in cancer of the breast are well known to all of you. More recently this tracing of old patients has been carried out most systematically by the Mayo Clinic, Dr. E. A. Codman of Boston, Dr. George Brewer of New York and others. I feel confident that ere long all hospitals will have a department devoted to the tracing of former patients. It is a task that can be admirably handled by the record department. This is a branch of hospital work that is as yet in

its infancy but one that will soon be of tremendous value not only to the hospital but also to the patients.

You and I scan the recent literature for methods that will enable us to do better work. Are we doing our share to enlighten the other fellow? We should publish our rare cases at once otherwise they are soon forgotten amid the multiplicity of other duties. The digest of groups of cases requires sometimes months or years before they can be analyzed so that the results may be of real value to the public. Not only should we do our share in publishing but our house staff should be stimulated to write short surgical articles. It is necessary for them to form the habit of putting down in print what they see for this habit will prompt them to read up thoroughly on the given subject. The older men thus learn from the younger men and the younger men profit by the mature judgment of their elders.

*Illustrations.* The attractiveness of any publication is greatly enhanced by good illustrations in fact a good picture is often worth more than ten pages of text. Have you noticed the wonderful improvement in the medical illustrations in the United States during the last twenty years—especially since the appearance of Dr. Kelly's work on *Operative Gynecology* in 1898? Max Broedel, Hermann Becker and August Horn were in large measure responsible for the inauguration of this improvement, which since then has been supplemented by other artists.

During the summer of 1909 while at my camp the thought came to me that it would be a splendid thing for American medicine if we had a department of art in medicine, where artists who wanted to make medical art their life work could get a training of two or three years. I felt that if this could be accomplished in ten years all the leading medical centers could have good medical artists and that in twenty years we should lead the world in medical illustrations. Any man writing a textbook scans the literature for good illustrations and would naturally select those from this country. This would carry American illustrations to all parts of the globe and greatly redound to the credit of American medicine. With fear and trepida-

tion I laid the plan before a broad minded and liberal business man who promised five thousand dollars a year for three years to see if the plan would prove a success. It was a success and at the end of the three years he consented to support it for two years more. Last February he again consented to supply funds for three more years. The last annual report of the Department of Art in Medicine as sent to the donor and to Dr. Frank Good now President of the Johns Hopkins University by Mr. Broedel, the Director showed that artists had been trained and sent to Boston New Haven Philadelphia Sayre Pa. Baltimore Richmond Cleveland, Chicago Rochester Minn. St. Louis El Paso and San Francisco. At the present time Mr. Broedel has sixteen artists in training.

I have dwelt at some length on this subject because some of you may know of artists who wish to take up medical illustrating as their vocation and also in order that you may appreciate what advances in this branch are being made in this country. I may say that the spare time of the director and his pupils is taken up in making illustrations for publications emanating from the Johns Hopkins Hospital and the Johns Hopkins Medical School. Nothing would afford me greater pleasure than to furnish you the name of the man who has given the forty thousand dollars for the maintenance of this department—a work that is doing so much to enhance the appearance and value of American medical publications and that will have an ever increasing influence in the future but the money was given anonymously and the modest donor refuses to let his name be known.

*The anæsthetic.* Until the last decade the administration of the anæsthetic was left largely to the junior interne. Consequently at the beginning of the scholastic year the surgeon was greatly hampered in his work until this assistant had gradually gained sufficient experience to enable him to give the anæsthetic fairly well. This defect was a great handicap to the operator and—what is far more important—was very harmful to the patients. This slipshod method of putting patients to sleep was a glaring defect in American surgery. At the present time many

of the larger and some of the smaller institutions employ expert anesthetists—men who do nothing else. That the profession is aroused to the need is evidenced by the large number of papers written on the subject. I would call your attention to the proceedings of the American Association of Anesthetists as published in the October number of the *American Journal of Surgery*.

For nearly twenty years Dr S Griffith Davis one of the most expert anesthetists in the country has put the majority of my patients to sleep. At the operating table I have been able to devote my entire attention to the operation, knowing full well that, if any untoward symptoms arose I should be notified at once. These patients were as a rule given just enough of the anesthetic to keep them asleep and consequently they would wake up a short time after the completion of the operation. Furthermore their period of nausea was usually much shortened.

Every interne, during his first fifty cases should be under the direct guidance of an expert anesthetist, and I feel sure that the time is speedily coming when all patients except in emergency cases in outlying districts will be put to sleep by specially trained men. How many of us will be satisfied with an inexperienced man when our turn comes to lie on the operating table? One and all of us will demand above all things the best anesthetist obtainable. The universal employment of the trained anesthetist will not only give the surgeon peace of mind but will materially increase our percentage of recoveries.

**Cancer** Much has been written and said about cancer but we are only just at the threshold of the campaign. In the advanced cases we can recognize it clinically and in the early cases diagnose it from the examination of portions under the microscope. Fifty years ago practically all malignant growths except skin cancers were fatal. Now we know that a certain percentage of lip, stomach, intestinal, uterine and other cancers can be cured. Our percentage of cures has improved with our improved technique. Our next step is to reach the cases early.

The Cancer Campaign Committee of the

Clinical Congress of Surgeons enlisted the services of that forceful and lucid writer Samuel Hopkins Adams. He gave us a two-page article in *The Ladies Home Journal* and followed it up with similar articles in *Collier's* and *McClure's*. These articles were copied or epitomized by many of the newspapers throughout the country. The immediate effect on the people throughout the United States was marked and many people with early carcinoma went to their family physician of their own accord. One member of this Association told me that as a result of the *Ladies Home Journal* article alone he had seen six early cases of cancer.

The Cancer Committee of the American Medical Association has also done much in disseminating pamphlets on the more common forms of cancer. Just here I should like to draw your attention to the many spheres of activity of the Council of the American Medical Association. This has been one of the most important committees ever organized in the United States and has done wonders looking toward the betterment of American medicine and surgery. Anyone who has sat in the House of Delegates of the American Medical Association and has listened to the various reports of this committee as read by its indefatigable secretary, Dr Frederick R. Green, must have been amazed at the fundamental plans which the committee has not only outlined but has also successfully carried out.

The American Society for the Control of Cancer a society supported in large measure by the laity has been and is now doing yeoman work in disseminating information relative to the early diagnosis of cancer. Mr Curtis E. Lakeman is the Executive Secretary. If any member of this society has at any time data that he thinks will prove of value in the diffusion of knowledge concerning cancer he will be greatly aiding the cause by communicating with Mr Lakeman who will soon see that this information if it proves suitable, is widely disseminated.

Many people already have been enlightened as to what may be accomplished if a cancer is operated upon early. All the patients must

be reached while the disease is still in the incipient stage. When this knowledge is widespread our results in cancer cases will be much better than they are today.

**Radium.** The use of radium is still in its infancy. You and I know little or nothing about it, but fortunately a few of the physicians in America have enough to try it out and to find what may be accomplished by its use. At the present time I think all are agreed that whenever a case is operable the growth should be removed with the knife and that radium should be employed afterward in suitable cases.

In our surgically inoperable cases we know that every patient must eventually die of the disease. If the radium expert treats all these he will undoubtedly lose a large percentage. Some of us are prone to call these failures, but this is hardly fair. We should ask what percentage of success he has been able to attain where we have absolutely failed. If he cures ten in one hundred of those we have sent away as inoperable and left to die, he has accomplished a great deal although he may have been able to do little or nothing for the remaining ninety. Some of our inoperable cases can be cured at least clinically; others can be temporarily relieved of their pain and discharge.

We as a nation should be thankful that we have enthusiastic members of the profession who are not only willing to spend a great deal of money but also devote most of their time in attempting to relieve a group of cases that are beyond surgical aid. I cannot refrain from briefly mentioning a case that came under my care in March of this year.

A woman, 5 years of age, was admitted to the Church Home and Infirmary, Baltimore, with supposed uterine myoma. On examination I found a globular tumor filling the pelvis and extending to the umbilicus. The glands in both groins were enlarged and nodular. In both axillae were nodules. In the right axilla was a nodule about 4 centimeters in diameter. A few days later numerous small shot-like or pea-like nodules could be felt along the legs and arms. I hesitated for a long time and finally decided to do nothing. The family was so insistent that I eventually consented to explore the abdomen. The pelvis was filled with a large mass, globular and so fixed that the pelvic organs could not be outlined. Occupying the right side of the abdomen

and firmly adherent to the large pelvic tumor was a second tumor about 2 centimeters in diameter. Many omental vessels ran directly into it. The omentum was studded with small oval nodules having sharp edges. I removed some of the omentum and closed the abdomen.

Microscopical examination of the omental nodules showed lymphosarcoma, and I told the family that nothing further could be done. The patient had a quaint little girl of four who was wrapped up in her mother and I could not get away from the thought of the tragedy in store for the child. Grasping at a straw I rang up my friend Burnham, gave him the details of the case and asked him if anything could be done. He said he would try and he did. The patient was given applications of radium at twenty-one different points extending over a period of eleven hours. She was greatly shocked, but gradually recovered. I examined this patient a few days ago. There was absolutely no trace of the abdominal or pelvic growth, and I could outline with the utmost ease the pelvic structures which seemed to be perfectly normal. The inguinal regions were normal. No tumors were palpable in the axillae, and all of the small nodules had disappeared from the legs and arms. He only complaint was a slight diarrhea.

It may be that the growths will return, but that remains to be seen. They are not there now and if the patient remains well say for a year, how much do you think that means to her little daughter and to the family?

At the present time we know of at least three good things that radium has done:

1. It has apparently cured a percentage of surgically inoperable cancer and sarcoma cases.
2. It has prolonged life in others.
3. It has relieved the pain and done away with or mitigated distressing discharges in not a few. In other words it has done enough to make us feel that we would want to have it tried on any member of our family that had an inoperable growth.

#### POST-GRADUATE WORK AND VACATIONS

I know of no other country where the surgical profession as a whole goes a visiting more than in America. And the interesting

On January 1, I in this patient again. On abdominal examination slight thickening could be made out in the right lower abdomen at the apex of the cecum. This area was very sensitive. On bimanual examination mass of about 2 centimeters in diameter could be detected just posterior to the uterus, and on rectal examination I could feel polypoid masses projecting into the bowel. The masses over these points was everywhere intact and the layers of the bowel did not seem diminished in caliber. There was no doubt that there was return of the growth and that this projected into the bowel from the outside. I advised the immediate use of radium.

April 24, 1917. Dr. Curtis P. Burnham informs me that there is absolutely no evidence of any abdominal or pelvic growth.

point is that, no matter where the surgeon may go he is always welcome and is shown everything of interest in the various clinics. The American surgeon realizes that he does not know everything and that in nearly every clinic he will find some valuable points to add to his store of knowledge no matter how rich.

The American Medical Association, the Southern Medical Association and the Clinical Congress of Surgeons at their meetings offer ample opportunity for the men to become well acquainted with one another. The individual members feel proud of the fact that their country contains in its medical ranks so many conscientious, capable and really brilliant men and that their profession is continually striving for the betterment of the lives of the people of the United States. These meetings so knit the North and South, East and West, that America becomes for the time being in reality a very small community. Much of permanent surgical value is gleaned at these meetings but still more important are the many friendships formed and the pleasant memories that prove a continual source of stimulus during the subsequent months and years. In the smaller and more limited surgical bodies such as the Southern Surgical and Gynecological Association, the members become even better acquainted; there is a warm feeling of comradeship and I know that in this Association each member feels that he is in reality a member of one large family and that every other member is a real brother. These smaller societies yield less to outside attractions, and consequently concentrate their attention on the scientific program and on the social functions arranged for them and their families. I have ample reason to know that in this association the members each year look forward with added eagerness to the annual meeting when they will again have the pleasure of meeting those who have become their lifelong friends.

The smaller interurban clubs which meet two or more times a year and spend a day or two at some surgical center are also of great value. A great deal of surgical work is collected for these meetings and one is thus

enabled in a short time to see more than he could ordinarily do in a week or even two. The tendency to visit surgical clinics is rapidly increasing; the visitors come not only from our own country but also from abroad. This is a clear indication of the confidence in which American surgery is held. Undoubtedly more visitors go to the Mayo Clinic than to any other in the world. Built up by the indefatigable energy of William J. and Charles H. Mayo, this wonderful clinic has added greatly to the prestige of American surgery and is an achievement of which the profession of the United States may well be proud. The dropping in to see what our colleagues are doing through the length and breadth of the land is bound to have a tremendous influence on the development of American surgery. The surgeons of this country as a whole have vision enough to see that regular vacations are essential to good work. The operator cannot regulate his work by the eight hour standard and must frequently toil long over time if he is to accomplish his task satisfactorily. If he continues to do this indefinitely he will lose not only his elasticity but also the keenness of his surgical judgment. The surgeon in many ways resembles the railroad engineer. He must always be on the alert for his passengers and in case of danger must often act with instant decision. Unless he takes the necessary vacation, he will either wear out or become a mere drudge. It is hard for any of us to realize that the world can move along serenely without us—but it can. Take plenty of vacation. One can do more and better work in nine months of the year than one can accomplish in twelve months. It does a man an immense amount of good to get away from the intensive work that has been absorbing his attention for months—that has made him totally oblivious to what has taken place around him—and to completely forget it for a few weeks. In the meantime he can view his work from the distance get a true perspective, see where he can improve his work and return with an added zest to his labors. If you wish to do your maximal amount of good work, you must take at least a two months vacation each year.

While in a retrospective mood let us consider two points in which we can improve. Some American surgeons when publishing papers, quote freely the French, German, or English authorities but apparently fail to realize that anything worthy of note has been done by their American colleagues. Some times they even completely ignore excellent work done by surgeons in their own cities. Let us avoid this brand of provincialism or highbrowism, for that is what it amounts to. Let our prophets in our own country come in for their just share of credit and place American surgery just where it belongs.

There is another group of very competent men who do nothing themselves, look wise and continually criticize and knock. They are like the Irishman who was always against the Government. It is our duty to evolve means whereby the energy of these knockers may be diverted into the right channels. If it cannot be accomplished otherwise they should be assigned surgical problems or be given responsible positions which will require so much labor and energy that they will have little or none left for knocking. They will also soon realize from experience that any man who accomplishes much is bound to make some mistakes and will learn to be more charitable in their attitude. Just criticism is desirable and very useful. Knocking hurts the fault finder and also tends to belittle the profession to which he belongs. There is no room for useless fault finding in the wonderful advance in American surgery.

#### THE TRAINING OF THE SURGEON

The father who has had a poor preliminary education but who has nevertheless forged to the front, is anxious that his son shall have the best education obtainable. We as surgeons should see that the coming generation the men who are to take our places have the best possible training.

Two essentials are necessary: a good preliminary training and the best possible medical course. The leaders in the United States have been fully alive to the situation. An editorial entitled "Medical Education—A Sixteen Years Successful Campaign" appeared in the *Journal of the American Medical*

*Association* August 19, 1916. This gives in a nutshell the wonderful progress that has been made.

In 1900 the *Journal* began collecting statistics relative to medical colleges, students and graduates and in 1901 a beginning was made in the great campaign for the improvement of medical education. In 1904 the American Medical Association created the Council on Medical Education under the chairmanship of Dr. Arthur Dean Bevan and by 1906 its work was well under way. By 1907 the Council had a complete list of foreign medical colleges and it was found that there were more medical schools in the United States than in all the other countries of the world put together.

Later tours of inspection were made to all medical schools in the United States and a definite campaign was waged to merge medical schools where two or more existed in one city. This campaign bore excellent fruit and by 1910 the number of medical schools had been reduced from 162 to 131. Meanwhile as stated, many of the institutions had undergone a remarkable internal development. Better teachers had been employed, better buildings erected, new laboratories established and better clinical facilities secured. Furthermore a remarkable improvement had been made in entrance standards.

From 1910 to 1915 the general study of medical education had been continued and during this period the number of medical schools had been further reduced from 131 to 95. Moreover 88 per cent of these had adopted higher entrance requirements. The editorial further says that the continuous agitation for better conditions in medical education had appealed to philanthropists to such an extent that endowments for medical education had been greatly increased, and large gifts for medical buildings, new laboratories, scholarships, endowed chairs and teaching hospitals had become of frequent occurrence. From the *Journal* we also learn that this country already has a score or more of medical schools which in every particular are equal if not superior to those to be found in any other country.

To those of you especially interested in

medical education I would commend a thorough study of the report of the twelfth annual conference of the Council on Medical Education of the American Medical Association held in Chicago in February 1916. To surgeons the article by Dr. Elias P. Lyon on

The Relation of the Laboratory Courses to the Work of the Clinical Years and the address by Dr. Lewellys F. Barker on The Relation of the Pre-clinical Laboratory Courses to the Work of the Clinical Years will be particularly instructive.

I have dwelt at length on the splendid work done by the Council of the American Medical Association in order that you may see that the medical teachers of this country are doing everything in their power to give the medical students of the United States the best possible training. In this connection I may mention a fact that is not yet generally known—that a somewhat similar attempt to standardize hospitals is being made by the American College of Surgeons in co-operation with the American Hospital Association and the Carnegie Institution.

The medical student, who after graduation decides to make surgery his life work should not take up his chosen specialty at once but should spend at least one year in a strictly medical service. A broad foundation in general medicine is absolutely essential. The following year can be most profitably spent in the pathological laboratory in making autopsies, studying diseases from the gross and histological standpoints and cultivating the bacterial flora associated with them. After this he should become a surgical interne under a competent surgeon. His time will now be occupied in taking histories, assisting at operations and in the after-care of patients. He will also have ample opportunity for studying all tissues coming from the operating room. He thus has a complete picture of the patient's condition from the time of admission until his discharge and from the laboratory findings has a clear idea as to the ultimate prognosis of the case.

After he has assisted from one to two years he is allowed to perform the simpler operations and by the end of the second or third year he is competent to handle the more dif-

ficult cases. After a year or two as resident surgeon he is amply fitted to start out as a full-fledged surgeon with the definite knowledge on the part of the hospital that he will be a credit to the school and to the institution from which he has come. I fully realize that many men are so hampered financially that these long years of study are almost out of the question and yet where there is a will there is a way. It is usually found true as many of us here this evening most vividly remember.

A lack of the knowledge of pathology is the weakest point in American surgery today. When most of us graduated there was no adequate training in either pathology or bacteriology. We have been forced to learn the basic principles of bacteriology in order that our surgical technique might be up to the standard but we have never had the time or patience to get a comprehensive knowledge of surgical pathology. As the surgeon grows older his time is more and more occupied and his opportunities for the study of pathology become less and less. It is our duty however to see that every piece of tissue that comes from the operating room is carefully examined histologically by a competent pathologist. In this way the final diagnosis of each case is reduced to a concrete basis. Now and again we shall find a carcinoma of the appendix where merely a chronic inflammation was suspected, tuberculosis of the tube where a simple salpingitis was deemed certain and sarcomatous degeneration of a myoma which at the operating table we had thought was a simple myoma undergoing hyaline degeneration. The surgeon of today in the majority of instances must rely on the verdict of the pathologist. The surgeon of the future must be an expert pathologist himself if he is to do his duty to the patient, and if America is to take its proper place in the surgery of the world. If we are thoroughly familiar with surgical pathology, gross and histological, we can on opening the abdomen, usually at once recognize the condition present. If we have little or no knowledge of pathological conditions however and if no pathologist be present, we shall often be at a loss as to what should be done. Sometimes we may cut out a piece of the diseased area for micro-



scopical examination and then close the abdomen. In other cases we may venture to complete the operation although still doubtful whether we should have attempted the complete enucleation or whether it would have been better to have left well enough alone. If the surgeon is a good pathologist a glance will often give the clue and if he be still in doubt, an assistant can at once make a frozen section and a glance at the slide will give us a positive diagnosis. I cannot too strongly emphasize the absolute necessity for us to be up and doing in the study of surgical pathology—a subject still greatly neglected in America. To practice surgery without an adequate knowledge of surgical pathology is like building upon the sand. No great building can be erected without good foundations. No surgical career will reach its maximal fulfillment without that bed rock foundation—surgical pathology. I know how difficult it is to find enough pathologists, the supply even now cannot keep up with the demand. Let me give you the plan adopted by the medical society of Waterloo Iowa a city of thirty thousand. The physicians clubbed together rented suitable quarters and placed Dr. Guthrie McConnell a well-known pathologist at its head. In this laboratory all pathological material is examined and all the examinations usually made in any clinical laboratory are carried out. The entire medical profession of the city have therefore a laboratory at their disposal, a laboratory to which patients are sent for various tests and where thoroughly trustworthy reports can be obtained. The society is most enthusiastic over the splendid results obtained in their own laboratory. In a small city or town there is absolutely no reason why two or three surgeons should not club together fit up a laboratory and engage a competent pathologist at a good salary to examine every specimen for them. They will thus do more for their patients and at the same time will find added pleasure in their surgical work.

For the young surgeon who after leaving the hospital still feels that he would like to perfect himself further the many experimental problems in the Hunterian laboratories

are most fascinating and profitable and we in this country are greatly blessed in having such splendid institutions as the Rockefeller Institute and the Rockefeller hospital, where especially promising men find ample opportunity for carrying on their work under the able guidance and co-operation of Dr. Simon Flexner and Dr. Rufus Cole.

How many of us know that the most extensive and most valuable collection of embryos in the world exists in the United States and that the majority of these have already been cut into serial sections and are available to us for careful study. We owe this collection to the foresight and untiring industry of Dr. Franklin P. Mall who from the time he came to the Johns Hopkins Medical School as its Professor of Anatomy at the opening of the school in 1893 has been collecting, sectioning, tabulating and studying all the available embryos. Dr. Mall is also director of the laboratory for Research in Embryology recently established by the Carnegie Institution and located in Baltimore. If you or I have some surgical problem that is difficult of explanation and the solution of which can be attained only by a study of embryology we can go to Dr. Mall, feeling perfectly sure that he will not only give us every facility for study but that he will place the necessary and I might say priceless sections at our command. We can in this collection speedily see more examples of a given type than we could ourselves collect in three or four lifetimes. This laboratory will be the Mecca to which the many students, both medical and surgical, seeking enlightenment along obscure embryological points, will come. This is another advance of which America may be justly proud.

At this point allow me to digress and for a few moments consider our own society. The founders of this society builded wisely and we can see a marked improvement each year. This advance is in large measure due to our quiet energetic and sagacious secretary Dr. William D. Haggard. His personality is so completely wrapped up in the welfare of the Southern Surgical and Gynecological Association that, when thinking of the society one instinctively thinks of him.

After trying to analyze the secret of the success of this society I have come to the conclusion that its method of organization namely the divorcing of the scientific from the business sessions has been an important factor. Then it seems that all of our members who take part in the proceedings aim to save their best work for these gatherings. But the most important of all is the fact that in the selection of the members so great care has been exercised that there is rarely if ever a discordant note. This society is really the clearing house for the year's work, and the stimulus obtained at these meetings is of lasting value. If the Councils in the future select as wisely as they have done in the past, this Association will have an ever increasing sphere of usefulness. Dr Haggard has very wisely had copies of the transactions sent each year to the leading libraries of the world. I think we might with profit distribute at least one hundred more to the smaller medical libraries in this country and abroad.

*Obituary* Since our last meeting the labors of three of our number have ceased. Dr Joseph A. Gale of Roanoke, Virginia, chief surgeon of the Norfolk and Western Railroad and a former president of the Medical Society of Virginia, having passed his three score years and ten, died on July 6, 1916 at the age of 74.

Most of us can enter or leave a meeting without being noticed, but there was one tall and striking member of our society who instantly commanded attention the moment he entered any meeting, and when he spoke his rapid flow of words reminded one of a Gatling gun. His method of teaching was graphic and telling; his operating fascinated the many visitors to his clinic. We can hardly realize that the indefatigable worker, the man that has done so much to advance American surgery is with us no more. That genial and warm-hearted Irishman, that great surgeon John B. Murphy, will always stand out as one of the great surgical landmarks of this generation. I am glad that Dr. Crile will tonight give you an intimate and extended view of his career.

We have lost another distinguished surgeon who for many years was active in this Association. Dr. Louis McLane Tiffany died suddenly at his country home, Mount Custis, Accomack Court House, Virginia, on October 23, 1916 at the age of 72. Dr. Tiffany was a graduate of the University of Cambridge, England, and of the University of Maryland. From 1874 to 1880 he was Professor of Operative Surgery in his Alma Mater, and from 1880 to 1902 occupied the chair of surgery. For years he was a consulting surgeon to the Johns Hopkins Hospital. In 1902 he retired from active duty with the title of Emeritus Professor. Dr. Tiffany was a man of rare personality and charm and was continually going out of his way to make smooth the paths of young surgeons. Let me give you a personal experience. Some twenty years ago Dr. Tiffany rang me up and asked me to meet him at the Church Home and Infirmary at two o'clock. I went there at the appointed hour and found him doing a complete breast operation. He turned to me and said, "This patient also needs an abdominal operation and I want you to do it." Needless to say he could have done the abdominal operation better than I could, but he insisted on my doing it, and he stood by quietly holding the electric light until I had finished my part. His sole object was to express his confidence in a young surgeon just starting on his career. It was a kindness that I shall never forget.

Dr. Tiffany was not only a brilliant diagnostician and operator, but was also continually working to improve and broaden the sphere of American surgery. He was one of the first in America to remove successfully a tumor of the liver. This case was reported in the *Maryland Medical Journal*.<sup>1</sup> The high esteem in which Dr. Tiffany was held is indicated by the fact that he was president of the Southern Surgical and Gynecological Association and of the American Surgical Association during the same year, 1895.

The memory of Louis McLane Tiffany will long be cherished throughout the nation.

In my address this evening I have not only endeavored to sketch for you the gradual

improvements that have taken place in American surgery but have also pointed out how much we owe to the other professions that are so closely allied to surgery.

President Wilson in an address delivered in Baltimore on September 25 1916 after referring to the wonderful resources of the United States said We had as it were, deliberately refrained from playing our part in the field in which we prided ourselves that we were most ambitious and most expert—the field of manufacture and commerce. All that is past and the scene has been changed by the events of the last two years almost suddenly and with a completeness that almost daunts the planning mind. Not only when this war is over but now America has her place in the world and must take her place in the world of finance and commerce upon a scale that she never dreamed of before.

My dream is that she will take her place in that great held in a new spirit which the world has never seen before not in the spirit of those who would exclude others but the spirit of those who would excel others. I want to see America pitted against the world not in selfishness but in brains.

What applies to the field of manufacture and commerce applies equally well to surgery. For several years the straws have been indicating the trend of affairs. The American requiring surgical treatment no longer goes abroad to be operated upon but prefers to be treated in his native land and the American surgeon himself when taken ill abroad strains every effort to get home and be operated upon by one of his confrères. These two points in themselves supply the most eloquent tribute that can be paid to American surgery.

From this evening's consideration of the status of American surgery we have gleaned several very important facts. We have vast sums invested in the hospitals of this country and the hospital authorities are making every effort to bring their institutions up to the highest standards of efficiency. Our nurses are vastly superior to those of any other country. We are improving and increasing our medical libraries, and the library of the Surgeon General, to which we all have access is

the most easily available and the most valuable in existence. We have an abundance of excellent medical journals. We have the only department of Art in Medicine in the world, a department which in the course of a few years will enable all the leading medical centers to have competent medical artists. We have for years had committees actively working not only to find out how our medical teaching may be improved, but actually raising the standards of our medical schools. We have a sturdy and intelligent class of medical students of whom any land might be proud. We have taken the public into our confidence and are educating them as to what can be accomplished when tuberculosis and cancer are recognized early. Above all we are raising the standards of the surgeon himself.

The great advances made in American surgery are the consequence not of any mushroom growth but of the steady and irresistible progress that was bound to follow the carefully laid plans of the last twenty years. If we look into the past we shall find that one country after another has forged to the front and assumed the leadership only to be outdistanced by another after a decade or two. We in America have profited greatly by the rich stream of medical knowledge that have been flowing to these shores ever since these United States were founded and many of us have had the privilege of studying in the medical centers of Europe. Are we capable of doing for the countries across the sea what they have done for us? We have an unrivaled equipment our surgery is unexcelled and our scientific work if based on a fundamental knowledge of pathology cannot be surpassed. Let us keep the light burning brightly during this long and pitiless war. When the great European nations are again at peace they will find among their Esculapian armies a new and powerful member one that is equal to any of them one that is eager and ready to join them in another war a war that will make glad the heart of every nation on this earth—a war not of destruction but one destined to lessen materially the sufferings of humanity and to lengthen the span of human life.

# SUBSTITUTION OF THE ANAL FOR THE VESICAL SPHINCTER IN CERTAIN CASES OF INOPERABLE VESICOVAGINAL FISTULÆ<sup>1</sup>

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NO doubt, due to better obstetrics vesicovaginal fistulæ are much less common today than formerly. Large defects in the vesicovaginal septum are rarely met with and no matter what may be the cause can usually be repaired by modern aseptic plastic methods not always at one operation but finally after a varying number of attempts. No case of vesicovaginal fistula, no matter how extensive should be considered hopeless from an operative standpoint provided the vesical sphincter and the adjacent portion of the urethra be intact. However the same cannot be said of those cases in which the vesical sphincter has been destroyed from excessive trauma and subsequent sloughing. No plastic surgery can make a sphincter muscle. It can repair but not create one.

In addition to those cases in which the vesical sphincter has been completely destroyed are cases in which it has been removed with more or less of the adjacent bladder and urethral tissue for malignant disease of these parts. There are still other cases in which from extensive trauma due to childbirth or other causes the bladder with a defective vesicovaginal septum is immovably fixed in the pelvis by adhesions from the introitus to the upper bladder wall. Attempts at repair of such cases are almost hopeless from the start although attempts at repair should be made since the vesical sphincter still persists.

In cases in which repair of the fistula and control of the urine is hopeless or in which the fistula still persists in spite of all attempts at repair the woman must be abandoned to her fate and left to pass an existence made miserable and pitiable by the constant dribbling of the urine or the rectal sphincter must be utilized for the control of the urine. The urinary stream can be directed into the bowel in a number of ways. The severed ureters may be implanted in the sigmoid or upper

rectum either by the extra or intra peritoneal route the ureters with a portion of the trigonum may be implanted with the bowel or finally an opening may be made in the vesicovaginal septum and the introitus closed (colpocleisis) so as to divert the urinary stream from the bladder into the vagina thence into the rectum where the latter will act as a reservoir for the urine by means of the rectal sphincter.

In 1899 (22) after an extensive series of experiments on dogs with different methods of anastomosing the ureters with the bowel I found that all efforts to prevent ascending renal infection in animals or in man by implanting the ureter in the intestine without its vesical orifice had proved futile. It is impossible to determine in advance of such operations the extent of the renal infection which will result from uretero-intestinal anastomosis since the patient may die in a few days of a pyremia or in a short time of pyelonephritis or in rare cases may recover from the infection with resulting contracted kidney. Evidently it would be unjustifiable to employ such an operation for the relief of a condition which intensely distressing from the patient's inability to control her urine is not dangerous to life.

In animals and in man it has been proved by numerous experiments and operations that ascending renal infection does not as a rule follow implantation of the vesical flap with the ureteral orifices into the intestine. Uretero-trigino-intestinal anastomosis (Maydl's operation) therefore is a perfectly justifiable and practical procedure. However the objection to its use for inoperable vesicovaginal fistulæ is that it is an operation of considerable magnitude and not unattended by danger of primary death. This leaves as a final recourse in a serious situation an operation where the ureteral orifices are left undisturbed thus reducing the dangers of ascend-

ing renal infection to a minimum and the diverting of the urinary stream into the rectum to be followed by a closure of the vaginal orifice. In the paper reporting the urethral experimental work already referred to I cited a number of cases reported in the literature in which such operations had been performed with good results so far as freedom from infection was concerned and the feasibility of controlling the incontinence by transforming the rectum and its sphincter into a urinary bladder. Particularly interesting was the case of Keen.

A woman of thirty four had been left with a vesico-vagino-rectal fistula from severe shingling after typhoid fever. After a number of unsuccessful plastic operations for the closure of the fistula the entire vulvar aperture was closed. Following this operation the patient defecated, urinated and micturated entirely by the rectum and was in perfect health twenty-two years after the operation with no signs of renal infection.

In 1904 (4—Case 39) I removed nearly the entire urethra for a malignant growth in a woman of sixty. Following the operation there was complete incontinence of urine with a prolapse of the bladder wall through the relaxed and dilated urethral opening. At a subsequent operation the prolapse of the bladder was cured by the closure of the urethral opening and the formation of a vesicovaginal fistula. Subsequently to relieve the great sufferings of the patient caused by the constant dribbling of the urine, a rectovaginal opening was made and the vaginal aperture completely closed. The patient made a good recovery and left the hospital in good condition, passing the urine by the rectum about every three hours during the day and only once or twice at night. Subsequently with the exception that both vesical and rectal openings had to be enlarged on account of contraction, the patient led a very comfortable existence until her death seven or eight years later from malignant disease of the os uteri.

In February 9 6 (3—Case 4) I performed at the University Hospital the same operation upon a woman of thirty-eight whose soft part had been frightfully mutilated by an instrumental delivery at her sixth pregnancy. Upon entrance to the hospital she had lost fifty pounds and was in a deplorable condition through the irritation caused by the urinary incontinence. An examination under ether showed the upper portion of the vagina completely shut off by adhesions with no traces of the cervix to be seen or felt. There was absolutely no giving either the anterior or posterior vaginal wall, the tissues resembling those met with in extensive pelvic inflammatory cases. An attempt to loosen the bladder wall about the vesical opening, which was larger than the end of the thumb, completely

failed. At a subsequent operation an opening one inch and a half by one inch, was made in the recto-vaginal septum just above the internal sphincter the rectal and vaginal mucous membrane layers being united by interrupted chromic catgut sutures. The tissues about the introitus were freshened and united by buried chromic catgut sutures with silkworm gut sutures for the skin, thus effectively closing the vaginal aperture. Healing was by first intention except for a small opening in the colopoeum which closed before the patient left the hospital.

The woman had been informed that she probably would either have to have the ovaries subjected to the X-ray or have them removed in order to prevent menstruation, since no cervix or cervical opening had been discovered at the operation. However just before leaving the hospital she reported that she was passing blood with the urine by way of the rectum. The passage of a catheter through the anus demonstrated the presence of urine, feces, and dark menstrual blood. Naturally she was discharged to wait developments.

In a letter from the patient received December 6 06 ten months after the operation she states she is in good health and very comfortable except for pain just before the flow starts. After the flow begins the pain stops instantly. She passes her urine by the rectum about every four hours during the day and once during the night. She is not constipated but has a number of liquid stools a day.

Evidently in this case there is a cicatricial contraction about the external os so closing the opening as to require some uterine contractions before the menstrual blood is forced through. It is extremely doubtful whether the cervical opening can be found and dilated through the vaginorectal opening since it could not be found at the operation when the shut-off upper vagina was in plain view. In case the patient has further trouble it would seem best to secure permanent amenorrhea by the methods referred to above although, as will be brought out later a study of similar cases shows that permanent amenorrhea is not common after these operations.

As an aid to the consideration of the different interesting problems the procedure we are studying offers, I have made a careful search of the literature for similar operations. I was somewhat surprised to find that 41 such cases have been recorded including two personal cases and one case operated upon by my former assistant, Dr. H. H. Cummings. Inasmuch as the task of collecting these cases has been somewhat laborious it

has been thought best in order to save some future investigator a similar labor, to give a short abstract of each case. Chronologically these cases are as follows

**CASE 1.** Reported by Malsonneuve (21) The patient had a large vesicovaginal fistula and the posterior wall of urethra was lost. In 1851 the vagina was closed except for an opening in which a catheter was inserted. Four days later union was complete except where the catheter had been. Into this opening an obturator was inserted. However, the patient could not bear this. Then the urethra was closed and a vaginorectal fistula was made which could not be kept open. The author intended to make a perineal fistula but the patient died from septic phlebitis before this operation was performed. Autopsy showed complete union of vagina, a vesicovaginal fistula 6 centimeters in circumference, a small fistulous opening between rectum and vagina, normal vaginal and rectal mucosæ.

**CASE 2.** Reported by I B Brown (3) Primipara, age 42. Instrumental delivery after 36 hours labor. Operated upon for fistula 16 years later (1861). Vagina nearly occluded fistula admitting finger into bladder urethra gone also a rectovaginal fistula. Vulva was closed and patient passed urine per rectum. Cured after four operations.

**CASE 3.** Reported by E Rose (26) The entire upper portion of the vaginal wall had been destroyed by diphtheritic ulcers, also almost the entire lower wall of the urethra. An opening was made into the rectovaginal septum 2 centimeters above the anus and about 2 centimeters wide. The mucous membranes of the rectum and vagina were united by three sutures the inner surface of the labia were freshened and united by suture. Nine months elapsed before the vagina was permanently closed. The patient was operated on in December 1871. She menstruated through the rectum. January 22 1873 the patient was able to hold urine 2 to 3 hours. Not until August were the three fistulae in the wound closed. The patient died in September 10 months after operation, from uræmia due to nephritis. Death was not due to operation. Autopsy showed the vagina and rectum normal.

**CASE 4.** Reported by E Rose (25) A patient aged 39 with a large vesicovaginal fistula had several unsuccessful operations up to 1883 when she was examined by the author. Very little of the urethra was left. During the winter of 1883-84 the vulva was closed and a rectovaginal fistula made. The vulva closed completely after five operations. The patient was in good health 19 years after operation. She is a hard working woman has never had any pain or untoward symptom from the operation. She urinates twice during night and is constipated.

**CASE 5.** Reported by E. Rose (25) The patient was operated upon in 1879 for carcinoma. Recurrence in 1886. The entire scar was removed also

the clitoris, urethra and finally the entire vesico vaginal septum up to the uterus. Eight weeks later on August 1, the vagina was closed and a rectovaginal fistula formed. A small fistula remained September 7 the patient could retain urine for one hour. However she died very suddenly from uræmia due to metastases on the ureters. Both ureters were dilated.

**CASE 6.** Reported by W W Keen (15) The patient aged 34, had a vesicovagino-rectal fistula from severe sloughing after typhoid. Several unsuccessful attempts were made to close the fistula. Finally the vulva closed. Menstruates and passes urine by way of rectum. Urinates five or six times during the day and once or twice during the night. No feces in vagina or bladder. Eleven years after operation a calculus was removed from the vagina. Recovery took place in three or four days. The subsequent history was entirely satisfactory. She was in perfect health with no signs of renal infection 22 years after operation. A small fistula formed which closed spontaneously.

**CASE 7.** Reported by Carrin (6) Primipara aged 23 had a vesicovaginal fistula after instrumental delivery in 1870. There was no trace of urethral orifice, and the entire superior wall and the cervix were involved, being almost entirely destroyed. Operation in 1876. Several operations were necessary before the vagina was permanently closed. Urinates every three hours per rectum. A mucous fold closed the fistula preventing feces and gas from passing into the vagina.

**CASE 8.** Reported by W Goodell (11) Primipara, age 25 years. Impacted shoulder several hours before physician came. There was sloughing of the womb of the base of the bladder and of the entire track of the vagina and all of urethra. The vagina nearly closed by cicatricial contraction urine dribbling constantly. Twelve years after confinement the vagina was closed and a rectovaginal fistula formed. At first passed the urine every few minutes later the patient could hold it for six hours. She gets up twice at night. Thirteen years after operations a fistula developed near the arch of pubic bone from which urine dribbles. There is much albumin in the urine. There was no menstruation after delivery. The vagina was permanently closed after two operations.

**CASE 9.** Reported by W Goodell (10) An unmarried girl in whom the cervix could not be found and the whole base of bladder was gone had a large rectovaginal fistula, caused by sloughing. All pelvic organs were matted together from neglected labor. The vulva was closed.

**CASE 10.** Reported by Morison (30) Quoted by Spinelli. Patient aged 23 entered clinic April 1876. Labor was difficult lasting six days forceps delivery. The urethra was completely destroyed also the vesicovaginal septum there were present prolapse of bladder and a vaginovesicorectal cloaca. May 28 1878 vulvovaginal occlusion. Two small openings remained. Repeated cauterization with

silver nitrate. Recovery complete. The patient left the clinic June 29, 1878, completely cured. She passes urine with the feces voluntarily by way of rectum. Two years after operation she was in perfect health. She does not menstruate.

CASE 1. Reported by Morisani (30). Patient, aged 32, entered clinic December 15, 1880. Protracted labor seven days, spontaneous expulsion of dead fetus. Clitral tissue in anterior quarter of vagina with central opening admitting the index finger. Destruction of the urethra and the entire vesicovaginal septum. Amenorrhea since birth of child. Urogenital cloaca with complete destruction of urethra. Perforation of rectum about 3 centimeters above the anus, vulvoanal occlusion May 30. The result not satisfactory. Further operations were necessary. After repeated cauterization with silver nitrate. The patient left clinic June 2, 1881. She passed feces and urine voluntarily by rectum for more than a year. She returned in January 1883. Two fistulous openings were found along the occluded vulva from which trickled urine. There was large number of calculi in the cloaca, some of good size. The rectovaginal opening had closed. The vulva was incised and calculi removed. The urethra passed an egg. The opening in the rectum was again made and the vulva closed. From then until 1903, he urinated by rectum. She has not menstruated.

CASE 2. Reported by Morisani (40). Patient, aged 34, was delivered by forceps in June 1883. It took 10 days labor. Feces and urine passed by vulva. Complete destruction of urethra and vesicovaginal septum. Perforation of rectum about 2 centimeters from anal sphincter. Rectovaginal cloaca. July 9, 1884, a laceration of vulva with complete rupture of second perineal body. July 7, 1884, malic urine, third perineal body. January 5, 1885, it was closed. A small penning made which was closed by a suture. She left the clinic July 6, 1885, completely recovered. She passed urine and feces voluntarily by way of the rectum. Two years after operation she was in good health, amenorrhea. She menstruates every 7 days.

CASE 3. Reported by Morisani (31). Multipara, aged 5, delivered by forceps after long labor, pathological puerperium, large urogenital cloaca, urethrovaginal septum completely destroyed. January 8, 1886, rectovaginal perforation with cauterization. Vulvoanal occlusion with silk suture. A fistula remained in the inferior angle of the wound which was closed by cauterization. She left the clinic July 6, 1886, fully recovered. She passes urine by way of rectum every two hours. One year after operation the condition was satisfactory. She retains urine three hours. There was no disturbance in intestinal function, amenorrhea.

CASE 4. Reported by Morisani (30). Primipara, aged 19, was delivered January 1886 after long labor and various perineal attempts to extract

the fetus. The urethrovaginal septum was completely destroyed and there existed a large urogenital cloaca. March 13, 1886, rectovaginal perforation with the cautery. April 5, vulvovaginal occlusion with suture. The result was not altogether satisfactory. On the eighteenth day after operation the patient was taken with pneumonia to which she succumbed.

CASE 5. Reported by Morisani (31). Patient, aged 3, delivered herself spontaneously of a dead fetus after three days labor in December 1886. Pathological puerperium, complete atresia of vagina. In the clitoral tissue is an opening admitting a small probe from which urine trickles continually. There is no opening of the urethra, a urogenital cloaca. Multiple incisions were made in the tissue and the vagina dilated until May 5, 1888, perforation of the rectum and vagina with thermocautery was done. Vulvoanal occlusion with silk suture. Three operations were necessary and then a small fistula persisted which was closed by cauterization. She left the hospital in July 1888, completely recovered. There was rectal incontinence every hour, no irritation, no pain in the rectum. There were no bowel movements very dry. Five months after operation the patient held the urine three hours. There was no pain in menstruation, no kidney disturbance. Urine in the rectum. Nothing heard from patient since then.

CASE 6. Reported by Morisani (31). Girl, aged 9, died gunshot wound. There developed a urogenital cloaca and complete destruction of the urethra and vesicovaginal septum. This occurred December 4, 1886. March 20, 1888, an opening was made in the rectum with the thermocautery. May 10, vulvoanal occlusion. Operation not entirely satisfactory. Rectal perforations with only partial success. July 3, 1889, there was still no passage in the urethra from the high urine flowed through the gland from the patient.

CASE 7. Reported by Morisani (30). Multipara, aged 30, fifth pregnancy. November 1887, three labor attempts, spontaneous deliveries. Fetus died during labor, one abortion in the seventh month. Last attempt to reach delivery. Immediately after delivery there was loss of urine from the vagina. Pathological puerperium. Large urogenital cloaca with complete destruction of urethra. Vesicovaginal septum. Inside of vulva a laceration of perineum to the anal sphincter. December 6, 1887, perforation of ectoanal septum with the thermocautery. January 3, 1888, perineorrhaphy and closure of vagina, good result. The patient left clinic March 5, completely recovered. During her stay in the hospital she urinated per rectum every two hours, no bowel movement a day. Function of anal sphincter perfect. Three years after operation the condition of patient was satisfactory, amenorrhea.

CASE 8. Reported by Morisani (31). Primipara, aged 3, was delivered by forceps of a dead fetus February 1888. Four days after delivery the urine trickled from the vagina. There was com-

plete destruction of the urethrovesicovaginal septum complete laceration of perineum and rectum to 5 centimeters from anal sphincter. Vescical mucosa outside of vulva prolapse of rectal mucosa, urogenitoretal cloaca. March 2 1888 enteroperineal rhyphy. In the rectal wound there was a fissure about 3 centimeters long. April 4 occlusion of vulva, partial success. May 3 a second operation. A small opening persisted which was closed by cauterization with nitric acid. The patient left the clinic July 22 1888 completely recovered. Urine was expelled from rectum every three hours one bowel movement a day amenorrhœa. In the course of six years the patient has been seen several times. The rectovaginal communication persists, an opening about  $1\frac{1}{2}$  centimeters long and 2 centimeters from anal sphincter. She urinates every four hours there is no disturbance in function of the intestine. The anal sphincter is weakened retention of urine is not perfect a small amount of urine escaping along the anal fold. Suffers from amenorrhœa.

CASE 19 Reported by Morisani (30) Primipara, aged 27 was delivered of a dead fetus by forceps in December 1889. Labor had lasted six days pathologic puerperium. Immediately after delivery there was incontinence of urine six days after fecal matter escaped from the vagina. There was prolapse of the anterior wall of the bladder and about 4 centimeters of urethra. In the rectovaginal septum is an opening about 3 centimeters in diameter the inferior margin of which is a little more than 2 centimeters from the anal sphincter urogenitoretal cloaca. January 15 1890 closure of the vulva partial success. Several operations after this. In June 1890 there was still an opening in the line of occlusion. On March 10, 1893 this opening was sutured, another operation before vulva was completely closed. April 5 1893 the patient was discharged from the clinic in perfect health. She passes urine and feces voluntarily by way of rectum amenorrhœa. Nothing heard since then.

CASE 20 Reported by Morisani (30) II para, aged 30 first labor normal followed by febrile puerperium. Second labor hard dystocia extraction of fetus difficult and complicated. Immediately afterward there was incontinence of urine the fecal matter passing from the vagina pathologic puerperium. Laceration of perineum second degree prolapsed anterior and posterior walls of vagina.

In anterior wall is a large opening resulting from destruction of almost the entire urethra and the vesicovaginal septum. There is much cicatricial tissue in the cloaca. There was not more than 2 centimeters of urethra left prolapse of vesical mucosa. On the posterior vaginal wall is a small opening establishing communication between the vagina and rectum urogenital cloaca. June 12 1892 suture of rectovaginal fistula with catgut formation of a new rectovaginal fistula about 3 centimeters from anal sphincter. The vaginal and rectal mucosa were united with catgut. Complete recovery from previous rectovaginal fistula arti-

ficial rectovaginal fistula sufficiently large. October 23 1892 vulvovaginal occlusion, partial success. November 13 another operation with perfect success. December 8 1892 discharged from clinic. Passes urine voluntarily by rectum obstinate constipation, amenorrhœa. April 1894 general health good, passes urine by rectum. From time to time a small reddish area is formed in the vulvar cicatrix which ruptures discharges urine and disappears.

CASE 21 Reported by Antal (2) Primipara, aged 22 had a vesicovaginal fistula from protracted labor. Greater portion of vagina was destroyed. The upper margin of the fistula and the remaining portion of the anterior vaginal wall were drawn back to the posterior vaginal wall, the side walls and lower margin of fistula were fixed to the symphysis. Only  $1\frac{1}{2}$  centimeters of the lower urethral wall was left. Almost the entire posterior vaginal wall consisted of scar tissue. Three unsuccessful attempts were made to close the fistula. A rectovaginal fistula was then made by removing from the rectovaginal septum a portion 1 centimeter in length by  $\frac{1}{4}$  centimeter in width. The mucosa of the rectum and vagina was united by suture. The vaginal orifice was then closed with ten silver sutures. A rubber tube was inserted into the rectum passing through the fistula and into the bladder and was left five days. After its removal the patient urinated per rectum every quarter to a half hour. A fistula persisted in the vagina which was finally closed by two metallic sutures after several attempts to close it with the thermocautery. Several months after operation the patient urinated per rectum every two to two and one half hours with no pain or any inconvenience whatever. She menstruates regularly by way of rectum with but little pain. There is no change in the mucous membrane of the rectum but she is rather constipated.

CASE 22 Reported by Lomer (20) Primipara aged 25 forceps delivery seven years previously. Soon afterward she suffered from involuntary micturition. Several unsuccessful attempts had been made to close the fistula also oblation of vagina. On entering the hospital April 27 1880 examination showed the following: vaginal orifice closed with exception of a fistula  $1\frac{3}{4}$  centimeters across and  $\frac{3}{4}$  centimeter long. Urethra  $1\frac{3}{4}$  centimeters long to anterior margin of fistula. About the center of urethra is a small opening vesicovaginal septum absent. From the os two scars pass over into posterior vaginal vault uterus movable conditions unfavorable. Attempts were made to close the fistula, and the patient remained dry for two days. The wound was not healed when the sutures were removed. May 27 formation of a rectovaginal fistula. On July 28 a rectovaginal fistula admits the tip of the finger. Gas and feces pass through vagina. Closure of defect in vagina and also urethra. August 12 a fistula formed in the lower angle of the wound through which pass gas and feces. January 28 1881 the following is found from the os extends bridge like scar tissue to the posterior vaginal vault.



and anteriorly to the rectal fistula. This does not allow the blood and urine to flow through the fistula but allows the feces to pass into the vagina. The scar tissue was cut but no better results were obtained. The patient was in worse condition than before. The rectovaginal fistula was closed again and the vagina opened.

CASE 23. Reported by Schroeder (4). Primipara, aged 32 entered clinic April 8 '88 was delivered by forceps in March, 1887 after protracted labor. Six days after delivery, urine and feces escaped by way of vagina. The bladder prolapsed the entire urethra and the greater part of vesicovaginal septum were gone. The posterior vaginal wall was preserved. About 4 centimeters above the anal sphincter is an opening easily admitting the finger. A vesicovaginal fistula admits two fingers. The edges of vulva were fresh red, the clitoris excised, and the vagina closed. Two fistulae persisted in the vagina one the size of a sound and the other the size of a lead pencil. Through these urine escaped constantly. The rectal fistula became smaller. Seven operations were necessary before the vulva was permanently closed and then a small fistula persisted through which some urine escaped. The rectovaginal fistula still had to be dilated every other day 12 months after operation. The patient urinated every 2 to 3 hours with great pain, was very constipated, and macerated per rectum. Symptoms became more and more severe and finally intolerable. Gas and feces passed into the cloaca. In October 1892 the vagina was opened again, and the patient was greatly relieved. All symptoms disappeared. The cloaca was filled with gas, feces, and urinary concretions.

CASE 24. Reported by von Dittel (7). II para, aged 30, was delivered by forceps. 875 Soon after urine trickled from the vagina. Examination showed a large opening from the vagina into the bladder. Only the anterior portion of the urethra exists. Closure of vagina November 1880. Six days after operation union seemed complete. However by December 26 there was an opening 2 centimeters long and 1 centimeter wide. Attempts were made to close it but without success. By January 88 the patient was in worse condition than before operation. An opening was made about 1 centimeter above the external sphincter drainage tube was inserted. The patient was anemic from loss of blood during and after attempts to close the vagina. On October 1881 the rectovaginal fistula was made larger by thermocautery. After seven operations and one year after the first attempt, the vagina was permanently closed. The patient retains urine 3 hours.

CASE 5. Reported by Kaltenbach (14). Operation performed as a last resort. The patient, aged 25 had had four operations for vesicovaginal fistula. There was cicatricial contraction of the vagina. Two unsuccessful attempts were made to close the fistula then a rectovaginal fistula was formed. Four operations were done to close the vagina.

results satisfactory. The patient urinates per rectum every 3 to 4 hours. The menstrual flow is by way of the rectum, without pain. No fecal matter nor gas in the vagina. The desire to pass urine comes on very suddenly showing that the bladder empties the urine into the rectum only after it is full. Three months after operation the rectovaginal fistula still had a tendency to contract but was large enough for index finger to pass. There was a mucous fold which closed the fistula and kept gas and feces from passing into the vagina.

CASES 6 and 7. Reported by Fritsch (8). One patient operated on years ago urinates per rectum no symptoms whatever. The second patient was operated upon four years ago she works hard, has no symptoms and urinates per rectum.

CASE 8. Reported by Kuester (18). Patient aged 55 had the entire urethra and also the vesical sphincter removed for carcinoma of the clitoris. On year after this operation, a large rectovaginal fistula was made and the vagina closed. A small fistula persisted but caused no little inconvenience that no attempt was made to close it. A few months later however the patient came back suffering intensely due to stones in the vagina. Six stones about the size of a pea were removed. At this time an attempt was made to close the small fistula. However it became larger. The patient urinates per anum every two hours and feels well and happy.

CASE 20. Reported by Lebedeff ( ). The patient, a peasant woman 28 years old, was perfectly well in her youth. She was married at 16 and soon after became pregnant. She was in good health until the end of pregnancy when she noticed swelling of the legs up to knees. Several hours after the beginning of labor she had convulsions. In labor five days spontaneous delivery of a large dead child. Immediately afterwards the patient could not retain urine. From that time on for almost 12 years she suffered from incontinence of urine and from irritation caused by the constant flow of urine. This finally led the patient to seek help at the hospital. Examination showed a generally contracted pelvis a tear of the perineum of first degree the labia majora chafed and extremely painful. On the right labium minus was an opening one half centimeter in diameter the left being torn to its base. There was no external opening of the urethra complete destruction of latter. Immediately behind the external opening into the vagina was a ring-shaped cicatrix surrounding an opening which admitted about half of the forefinger. There was a mass of scar tissue from the neck of the bladder to the anterior wall of vagina and passing into the ring shaped cicatrix described above. All this was apparently the result of protracted labor with a large child passing through the contracted pelvis. January 1900 an artificial rectovaginal fistula was formed, about 2 centimeters long, and the edges of the vaginal and rectal mucosa were united with catgut. A drainage tube 6 centimeters long was inserted and removed on the ninth day. The patient menstruated

with but little pain. On February 2 the vagina was closed. Three days after operation the patient menstruated with great pain. At the next menstrual period there was no pain. She controls urine during day urinating every 3 to 4 hours. Three and one half months after operation, the condition of patient was as follows. She is able to retain urine 3 to 4 hours and even longer. The urine is clear no albumin. Menstruation every three weeks lasting 3 to 4 days without pain, no clots. Fecal matter never passed into the vagina. The patient feels so well that she considers herself entirely recovered.

CASE 30. Reported by Jakowlew (12) Primp-ara, aged 26 was admitted to the hospital June 2 1889 complaining that she could not retain her urine. One and one half months previous to this she had given birth to her first child. Labor lasting four days child dead, unusually large. The mother was in bed a long time. After this she noticed urine continually dribbling from the vagina. There was nothing abnormal in the pelvic cavity except a fistula which admitted the end of the little finger and was surrounded by scar tissue. Through the external opening of the urethra, no catheter nor sound could be passed. The vaginal walls were formed of scar tissue. A finger could be passed through the opening in the vaginal wall into the bladder. The cervix could not be reached. There was also an opening into the rectovaginal septum. It was impossible to perform any plastic operation. September 30 episiotomy. The entire first week after operation a large part of the urine was passed per rectum and the patient remained dry. On October 7 the sutures were removed and the wound was healed throughout its entire extent. On October 1 a small fistula was discovered in the upper part of the wound which allowed urine to escape. By November 7 the urine ceased to flow through the fistula in the upper part of the wound. Two months after the first operation, urine flowed from the vagina into the rectum and was retained there. On November 26 episiotomy was completed no untoward symptom after operation. Two months have passed and patient remains dry. The urine accumulates in rectum and is retained there 2 to 3 hours and sometimes even longer. November 29 to December 5 patient had diarrhoea which was rather profuse. After cessation of this to the time when the patient left the hospital, January 25 1890 there were no pathologic manifestations.

CASE 31. Reported by Koteljansky (17) Patient aged 25 married 5 years, gave birth to a full term dead child. Parturition difficult lasting 48 hours. Several hours after delivery she noticed involuntary flow of urine. She entered the maternity clinic November 3 1889 two months after delivery. The patient was weak, exhausted, pale and thin chest normal blood normal. The labia were normally developed. A catheter inserted into external opening of the urethra entered to a depth of about 0.5 centimeters. This was the only part of the urethra which remained intact. In the

vagina were bands of tissue and even after their removal the finger could be inserted only 3 centimeters. The cervix could not be reached. In the anterior and posterior vaginal walls were openings communicating with the urethra, bladder and rectum. The urethrovaginal and vesicovaginal fistulae were fused in consequence of which the middle portion of the front wall of the vagina was absent. The rectovaginal fistula was in the most remote part of the vagina. On November 10 the urethrovesicovaginal fistula was closed with carbolic silk six deep and four superficial. This was unsuccessful. November 28 a second operation was performed with negative result. When stitches were removed December 4 it was noticed that the rectovaginal fistula had closed. Four other attempts were made to close the urethrovesicovaginal fistula with out success. The patient made a good recovery after each operation. It was now decided to close the vagina and make a rectovaginal fistula. The patient went home May 1890, to improve her health and returned September 21 1890. The entire vagina was covered with cicatricial tissue even less penetrable than before. Her general health had improved. The operation was done at two different stages first the formation of a rectovaginal fistula and second episiotomy. On October 6 1890, the rectovaginal fistula was formed 1½ centimeters in width. A drainage tube was inserted and taken out the sixth day. Union of vaginal and rectal mucosa was so firm that no trace of it could be found. The bowels moved twice a day and did not pass into the vagina. On October 21 the patient began to menstruate flowed only twenty four hours. October 26 episiotomy was performed. On the first day the urine was passed through the anus patient dry. Micturition 3 to 4 times a day. October 29 there were signs of irritation of the bladder the urine was discolored, temperature 38°C. This was the only rise in temperature during her stay in hospital. Four operations were necessary before complete closure of vagina was effected. November 26 patient was dismissed from the hospital in perfect health.

CASE 32. Reported by Rossi (28) Large vesicovaginal fistula with destruction of urethra. Formation of a rectovaginal fistula and colpocleisis. Anal sphincter retains urine 2 to 3 hours.

CASE 33. Reported by Lipsky (19) The patient aged 28 had had an abscess in the right inguinal region leaving a fistula. This occurred two years before marriage. One year after marriage another abscess formed in the region of the right posterior iliac spine. Two years after marriage the patient had typhoid fever. Fifteen months after this she was delivered of a dead child after three days labor. Two days after delivery she began to urinate involuntarily and two weeks later July 25 1891 she came to the clinic patient anæmic. On the anterior wall of the vagina, at the level of the margin of the vaginal introitus is a fistula leading into a cavity in which the horizontal and de

ascending branches of pubic bones are felt below. The uterus is distinctly palpable by rectal touch; the vagina is much retracted. The vaginal mucosa consists of cicatricial tissue. There is little left of the urethra. Several attempts were made to close the fistula, but they were unsuccessful. The patient left hospital to improve her health. She entered again October 4, 1890. October 11 epiphractesis was performed but on removing the sutures there was still a small fistula in one corner. On November 15 a second operation was performed resulting in complete union. However there was incontinence of urine and a rectovaginal fistula had to be made. Incision in the antero-rectal wall 2 centimeters long at level of superior fibers of anal sphincter. A flap was dissected from a haide of the vulva and the freshened surfaces were united with metallic sutures. A Nelaton catheter was introduced into the vagina through the external fistula. The catheter was obstructed the first day and a glass tube had to be inserted. Several operations were necessary before union was complete and then a small fistula remained. The patient was weakened from the repeated operations. She left the hospital to rest her health. The urine still flowed involuntarily. Little by little the urine ceased to flow. In August of the following year she urinated 3 to 4 times in 24 hours, not during night. She has no pain, the urine is clear, reactions of stools normal.

CASE 34. Reported by Lipunsky (10). Primipara, aged 35, delivered 3 years before a dead child labor lasting 3 days. Delivery was followed by fever and involuntary micturition. On January 3, 1896 she entered the hospital. External urethral orifice leads into a canal 1 centimeter long. The superior edge of the fistula is formed by a flap extending to the postero-vaginal wall. The uterus cannot be felt. On the posterior vaginal wall is a semicircular cicatrix surrounding a rectovaginal fistula 1 centimeter in length. Epispadias. Small fistula persisted in superior angle of wound. This was closed by a second operation.

CASES 35 and 36. Reported by Ryttygier (9). Entire urethra and neck of bladder removed for carcinoma. Two cases. In order to keep fecal matter from entering the vagina and bladder a triangular flap was cut from the posterior vaginal wall thus forming a triangular rectovaginal fistula. This flap was then placed into the rectum the fistula closed from the bottom up so that there remained only a funnel-shaped opening above. This flap acted as a valve and allowed the urine to pass into the rectum but not the gas or feces into the vagina. The opening must not be left too large or else the flap might swing through it into the vagina. The vagina was then closed.

The first case was not successful because the patient did not remain in the hospital until the vagina was completely closed. The second patient still had a small fistula in the wound to be closed later.

CASE 37. Reported by Khatchkian (6). In this case there was great loss of substance after delivery.

A longitudinal opening was made into the recto-vaginal wall and the vagina closed after five operations. Two months after operation the patient urinated by rectum every 3 to 4 hours. Menstruation was per rectum.

CASE 38. Gallet (6) mentions a case in which a vesicovaginal fistula existed. The vagina was closed and an opening was made into the agnathorectal septum. The patient lived well and was able to hold urine 10 hours.

CASE 39. Personal case described at the beginning of article.

CASE 40. Reported by Cummings (3). A patient aged 65 had extensive sloughing of the bladder following vaginal hysterectomy. There was a large mass of inverted bladder mucosa in the vagina and ureteral openings so near the edge of the opening as to preclude closure of the fistula. The result after a number of operations was not entirely satisfactory since it was impossible completely to close the vagina. A small opening persisting near the slit of the urethra through which a small amount of urine escaped. The patient is quite satisfied when she compares her present condition with what she suffered prior to operation.

CASE 41. Personal case described at the beginning of article.

#### DATES OF THE OPERATIONS

According to Lipunsky the first utilization of the rectal sphincter for the control of the urine after the formation of a vesicovagino-rectal fistula and closure of the vagina (colpocleisis) or the vulva (epispadias) is to be credited to Maisonneuve who performed the operation but without success. The operation had been suggested but not practiced by Jobert in 1836 and Bernard in 1845 (see Amable bibliography). It is interesting to study the occurrence of the operations by decades since naturally there would be more prior to the perfection of plastic pelvic surgery. In the following table the cases are arranged by decades in accordance with the dates of the operations or where those are omitted according to the time the cases are reported.

#### Cases by Decades

1835 to 1860	
86 to 87	
87 to 88	7
88 to 89	
89 to 90	7
90 to 91	1
91 to 92	2

The large number of cases during the decade 1881 to 1891 may be explained by the

great number of the operations in question (11) performed by Morisani and reported by Spinelli. It is a large number of operations to be performed by one man and can only be accounted for by poor obstetrics and that the unfortunate victims of such work were brought to Morisani's clinic and were in such a condition that plastic surgery was hopeless. I would like to think that all such obstetric injuries in this country since 1901 had been referred to skilled plastic surgeons who had cured them all. However I am inclined to think that the value of the operation for the relief of women otherwise doomed to miserable existences has been lost sight of for I cannot believe that Dr Cummings and I are the only operators who have been unable to cure these terrible injuries of the soft parts. Yet the fact remains that only three cases have been reported in the last fifteen years.

#### CAUSE OF LESIONS PRODUCING INCONTINENCE

In 8 cases no cause was mentioned for the defects giving rise to the incontinence. Of the remaining 33 cases childbirth with or without instrumental delivery was given as a cause in 25 cases. In Keen's case previously quoted extensive sloughing followed an attack of typhoid fever while in Cummings' case a large part of the vesicovaginal septum was destroyed by sloughing following a vaginal hysterectomy.

In 4 cases the operations had to be performed on account of the incontinence following removal of the urethra and portions of the bladder for malignant disease. Fortunately primary carcinoma of the urethra is rare but when it is met with one should not hesitate to make an extensive removal for fear of the resulting incontinenes which can be subsequently overcome by the operative procedures under discussion.

Diphtheritic ulcer and gunshot wound were given as causes of the lesion in the two remaining cases.

#### NATURE OF THE DEFECT

The nature of the lesions giving rise to the incontinence varied from vesicovaginal fistulæ with more or less complete destruction of the

vesicovaginal septum to lesions where the urethra was partially or wholly destroyed with fistulæ involving the rectovaginal septum. In 10 cases there were vesicovaginal fistulæ while in 13 cases there was complete destruction of the urethra. In two cases in addition to other defects there were complete tears of the perineum.

A study of the cases will show that most of the operations were performed for most serious conditions of the soft parts after plastic operations had been tried and failed except in those instances where restoration of function was hopeless from the start because of loss of the vesical sphincter. This brings up the question of how many operations a patient should be subjected to when there is failure of plastic procedures. After a fair trial has been made and very little has been gained the patient should have the procedure under discussion explained to her as she may prefer it to repeated trials with very little hope of success. In a way every case of the operation we are considering is a confession of failure. It is not and never will be an ideal procedure. At the most it is merely a way out of a serious difficulty. Especially is it objectionable since it precludes copulation a vital objection in the case of the married woman. On the other hand, where the parts are intensely irritated by urinary and faecal discharges intercourse is just as much interdicted while in the one case the woman has great suffering and in the other she is able to have a fairly comfortable existence.

#### THE TECHNIQUE OF THE OPERATIVE PROCEDURE

As the procedure in the great majority of cases is for the relief of urinary incontinence due to a vesicovaginal fistula the formation of the latter as a part of the operation is reserved for those cases like my first one where the vesical sphincter is impaired by the removal of malignant tissue. It must be borne in mind that these artificially made vesicovaginal fistulæ must be large enough to allow for subsequent contraction. One does not hesitate to remove enough tissue from the vesicovaginal septum to prevent the consequences of such contraction the formation

of vesical calculi which were reported in four cases. As a further aid toward preventing contraction the vesical and vaginal mucous surfaces about the fistula should be united by interrupted catgut ligatures.

The same warning holds true for the artificial rectovaginal fistula. It should be made just above the internal sphincter muscle longer longitudinally than laterally but large enough to admit two fingers easily. The two mucous surfaces should be united by chromicized catgut or silk sutures. Spinelli worked out on the cadaver a somewhat elaborate technique for the formation of the rectovaginal opening designed to prevent feces from being forced into the vagina and giving at the same time easy passage for the urine into the rectum. As a matter of fact such technique is unnecessary since a study of the reported cases shows that a natural valve is formed after the making of a simple opening into the rectum so that feces do not flow into the vagina consequently this accident need not be guarded against.

A drainage tube was used in the rectum in 9 cases. I very much doubt the necessity for its use and in another case I would dispense with it altogether depending upon thorough paralyzing of the sphincter muscle by stitching and the occasional passage of the rectal catheter. A drainage tube even within the rectum causes considerable irritation much more so if it be passed into the bladder by way of the rectal and vesical openings.

In 15 cases the operations were performed in two stages the fistula vesical and rectal being made first and the vagina subsequently closed. The advisability of the two-stage procedure will depend upon the nature of the case being probably necessary in the presence of great irritation. However in the majority of cases a one stage operation will suffice and give just as good results.

#### MORTALITY OF THE OPERATION

Since the peritoneal cavity is not involved either in the formation of the vesicovagino-rectal fistula or in the closure of the vagina there should be no primary mortality connected with the operation. This is borne out by the study of the cases since in only one

instance Maisonneuve's case where the patient was operated upon in 1851 did death occur directly from the operation. This patient died of a septic phlebitis a result easily avoided today. One of Morisani's patients died on the eighteenth day of pneumonia apparently unconnected with the operation. One of Rose's patients died ten months after the operation from nephritis which an autopsy showed did not result from the operation. Another of Rose's patients died about nine weeks after the operation which was performed for incontinence following the removal of the clitoris, urethra and the entire vesicovaginal septum. Death resulted from uræmia due to pressure of malignant metastases upon the ureters.

Therefore it may be concluded that the operative procedures are not dangerous hence are justifiable for the relief of conditions which in themselves do not threaten life.

#### RESULTS OF THE OPERATION

It is exceedingly difficult to secure primary union of the colpocleisis portion of the operation as shown by the fact that in only two instances did this part of the wound heal by first intention. The resulting fistulae, however, heal rather readily after the application of caustics since there were only 6 cases of persistent fistulae. That precautions must be taken against contraction of the rectovaginal opening is shown by the fact that such a contraction was mentioned in 9 cases.

#### FUNCTIONAL RESULTS

Experimental work and a study of the reported cases show that the rectum can be used as a substitute for a urinary bladder without giving rise to rectal irritation. In not a single case of the 41 was such irritation reported. The urine does not give rise to uncomfortable diarrhoea, although the stools are somewhat softened by the urine. At times small amounts of liquid feces are passed with the urine. Usually however there are one or more formed stools a day in addition to the passage of the urine at frequent intervals. In 5 cases the patients were reported as being constipated.

The length of time between the rectal

urinary evacuations was mentioned in 23 cases. The urine was retained between two and three hours in 5 cases while in 1 case each it was held for one hour six and between six and eight hours. It is very possible that highly concentrated urine would cause a certain amount of irritation of the rectum and lead to increased evacuations but such a condition of affairs could easily be overcome by a medicinal treatment.

Considerable interest centers about the menstrual function after the operation. Since most of the women are at the child bearing age and are menstruating regularly at the time of the beginning of the incontinence the menstrual blood must either pass by way of the anus or be retained within the uterus. In 12 cases the women menstruated after the operation through the rectum without apparent inconvenience while in 9 cases menstruation ceased after the operation without apparent cause unless it could be explained as due to the trauma giving rise to the vesical defects. Whether menstruation ceased or persisted there was no particular reason to fear colon infection of the endometrium from fecal contamination through the rectovaginal opening. In the first place usually the vagina is free from feces and secondly cases where there are extensive rectovaginal fistule with a bathing of the cervix with fecal matter do not result in infection of the uterus.

The steps necessary to be taken where there is retention of menstrual blood from adhesions about the os have already been considered.

#### ASCENDING RENAL INFECTION

There was absolutely no proof that the formation of the cloaca resulted in ascending renal infection. In my first case the urine was collected examined and found normal. The only doubtful case already mentioned was one reported by Rose in which the patient died of nephritis ten months subsequent to the operation. However Rose had in mind the possibilities of ascending renal infection and says distinctly in the report of the case that the autopsy showed that death was not due to anything connected with the operation. Again let it be stated that this

freedom from ascending infection is undoubtedly due to the fact that the ureteral orifices have not been interfered with and that very few colon germs find their way into the bladder.

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## SUBTOTAL THYROIDECTOMY

B. WILLARD BARTLETT, M. D., IACUS, S. LOU

INCOMPLETE relief for a comparatively large percentage of toxic goiter patients after unilateral thyroidectomy long ago convinced me that something more extensive in the way of operative therapy was indicated in many of these cases. It was then natural to add ligation of the opposite thyroid vessels and later on a partial resection of the second lobe at the time of the original operation. It was only after being driven to a considerable number of secondary partial lobectomies that I became thoroughly convinced that we must make the original operation more extensive than had hitherto been contemplated if we were to expect the complete relief of toxic symptoms in a large percentage of these patients.

The desirability or even the necessity of removing at times a large portion of thyroid tissue from both sides seems to be a rather recent outgrowth of unsatisfactory experience in this work. Kocher in earlier editions of his *Technique* makes no mention of bilateral lobectomy and gives only a few lines to bilateral resection.

How different is now the inclination at the Mayo Clinic as expressed by Balfour (1). In the large majority of these cases the process of disease is not confined to one lobe. Although one lobe may be much larger than the other yet a similar condition exists to a lesser degree on the opposite side. Extirpation of a single lobe and isthmus in this type is rarely a satisfactory operation. It is therefore necessary in many of these cases to remove

portions of both lobes. This fact is well illustrated by statistics from the Mayo Clinic during 1913. Of 763 non-toxic thyroids 533 were classified as multiple adenomata or diffuse colloid the remainder being single adenomata cysts etc. Of these 533 an extirpation of one lobe and isthmus was performed in 18 per cent in 25 per cent one lobe the isthmus, and part of the opposite lobe were removed while in 57 per cent a double resection was done. This is suggestive and indicates that greater efforts are being made in the surgical treatment of goiter to obtain not only satisfactory results but to obviate as much as possible a recurrence of the condition.

The same author is convinced that no distinct line can be drawn between toxic and atoxic goiters as shown by the following:

It is well known that goiters which for some years have produced no recognizable symptoms may gradually become associated with marked degenerative changes in other organs particularly those of the cardiovascular system.

We surely can find justification for the removal of relatively large amounts of thyroid tissue as a routine procedure. There are of course isolated instances in which the ablation of a cyst or of a solitary adenoma may completely satisfy the requirement at hand that this cannot be true in the great majority of cases however becomes apparent when one contemplates that enormous Mayo Clinic experience summarized by Balfour (1) viz.

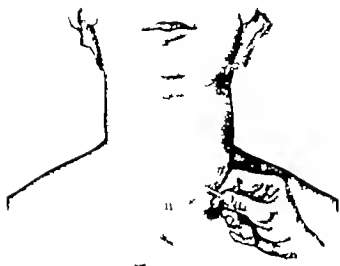


Fig. 11. Marking the line of incision while the patient is in the upright position.

It is difficult to classify with any simplicity the various changes which are found in enlarged thyroids which are not associated with symptoms of disturbed function. It is accepted in our clinic that the non-toxic goiter is one in which there is no evidence of an epithelial hyperplasia or hypertrophy sufficient to characterize the gland. These simple enlargements of the thyroid may therefore be conveniently divided into two groups (a) symmetric or thyroidal shaped goiters (b) asymmetric or nodular goiters (MacCarty 4). In the first group the diffuse hypertrophic colloid is the most typical and frequent and is seen chiefly in the young individual. That this type of gland may undergo cellular hyperplasia and produce constitutional symptoms is recognized. Between this glandular hypertrophy and the typical hyperplastic thyroid every possible pathologic picture may be presented which explains the confusion existing in classifying these changes. The second group or the asymmetric enlargements are practically always due to single or multiple adenomata. The essential pathology of many of the atoxic goiters examined in our clinic is confined to the presence of single cystadenoma. In 45 per cent however the increase in size is due to multiple adenomata of various types (Wilson 5). These are seldom confined to one lobe although as a rule one lobe usually the right is considerably larger than the other. On the other hand nodular thyroids may still retain considerable resemblance to symmetrically enlarged thyroids. Adenomata may undergo almost any form of degeneration—cystic (though true cysts are rare) fatty necrotic hemorrhagic (recent or old) calcareous, hyaline malignant etc. Various combinations of these may be found in the same gland following the primary condition of multiple adenomata.

Does it not then seem rational to conclude that the needs of most goiter patients will be



Fig. 12. Chain falling naturally in position to cover scar.

met by a type of routine operation which removes a large portion of thyroid tissue especially if a symmetrical reconstruction of small lateral lobes is made?

Balfour (1) writes after an exhaustive study of the literature

The function of the thyroid in the human being is problematic. It has long been known that the gland is absolutely necessary to normal metabolism and that its rôle is probably dependent on an internal secretion yet in spite of extensive experimentation the true active principle in this internal secretion is still unknown. Neither has its method of action been discovered. Thus far our knowledge is practically limited to the fact that iodine in various combinations particularly thyroïdin discovered by Baumann in 1895 is an essential to the thyroid but as yet no chemically pure substance which retains its physiologic activity has been isolated. The gland is indispensable to the maintenance of healthy life and in order to explain its function innumerable experiments have been made and many theories advanced but all such theories are still conjectural.

It is hardly germane in a purely technical study of this kind to consider goiter as anything but a tumor in the broadest sense. Still I must add for the sake of completeness that a preliminary study of these cases is facilitated by following Plummer's (3) division of them into four groups (1) non hyper





Fig. 3. Patient in position for operation. The head thrown back as far as possible without interfering with respiration. The tumor and the thyroid gland are prominent.

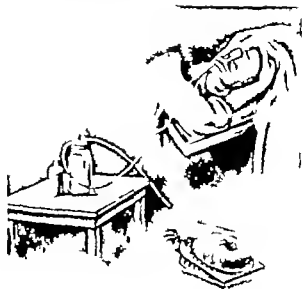


Fig. 4. Anesthesia apparatus.

plastic atoxic (2) non hyperplastic toxic (3) hyperplastic atoxic (4) hyperplastic toxic.

When we come to consider *exophthalmic goiter* one cannot discuss fully in a paper on technique the important matters of preliminary ligation condition of the patient skull experience and judgment of the individual operator etc. It is sufficient for the purpose in hand to assume that we are dealing with a patient who finds herself in a quiescent interval and is as fit as she can be made for the removal of thyroid tissue. The question which here confronts us is, the amount to remove. Balfour answers it in the following words:

In our clinical removal of a large part of the hyperactive gland is practiced, and so far as is known there have been no symptoms which might be due to deficient thyroid secretion in any of the patients with exophthalmic goiter. The entire right lobe isthmus and a part of the left lobe sometimes as much as four fifths of the active gland, should be removed, as a rule. It is still unlikely that in performing a so called total extirpation of a lobe, small almost imperceptible pieces of gland tissue may be retained which will perform a part of the thyroid function. Although the tendency is to remove more of the gland, yet practically never is less gland retained than the size of the normal gland.

Hunnicutt (10) did extensive removal of dogs thyroid with the result that no myxedema appeared when an exceedingly small portion of the gland was left behind.

The subtotal removal of one of the system of ductless glands viz the thyroid no doubt has some effect on the others related to it though very little definite clinical knowledge exists on this subject. Halsted (9) after extensive experimentation discusses the effect upon the other ductless glands notably hypophysis and parathyroids. He thinks that the changes which have been noted in other ductless glands after almost complete thyroidectomy even if colloid is found in their substance may be evidences of normal or hypoactivity rather than of compensating hyperactivity.

C. H. Mayo (11) struck the key note of my subject when he wrote after 5000 goiter operations had been performed at Rochester:

Operation in cases of hyperthyroidism appears to give about 75 per cent of cures, while the remaining 25 per cent are more or less benefited according to the degree of complication at the stage of the disease. Probably 10 per cent have some degree of relapse in from one to three years after operation usually manifested by the return of symptoms. In these rare cases further operation by ligating the vessels and in most cases by removal of a portion of the remaining lobe improves the condition of the patient by reducing the amount of thyroid secretion.

As stated by C. H. Mayo (11) the secretion of the thyroid has very much to do with mental and physical development. The tech-

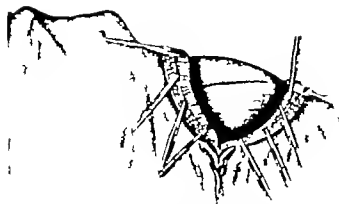


Fig. 5 The sheets surrounding the site of operation and covering the patient's body are carried up over the face thus securing for the operator a perfectly free field.

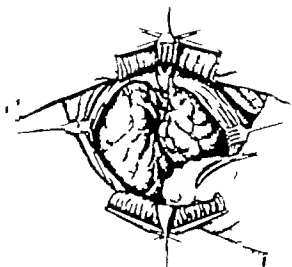


Fig. 6 The lateral lobes of the thyroid are exposed by the customary transverse division of the ribbon muscles.

nique proposed herewith must then be employed only in the treatment of adult patients.

Between July 1915 and July 1916 I performed subtotal thyroidectomy on 26 patients employing the technique which is detailed under the following eight captions.

1 *The skin incision* Kocher's collar incision seems best adapted to the surgical exposure as well as to the later cosmetic requirements. The examination of many necks after operation from my own and other clinics demonstrating scars varying in shape from the letter U to a straight line convinced me that an incision cannot be most advantageously placed after the lady is in the recumbent position with the chin elevated. It is taken for granted that most women will want to cover the scar for the first year at least with a chain or string of beads. (A few will consent to wear a ribbon over a high transverse cicatrix which has resulted from an attempt to excise old ligation scars.) What is then more logical than to mark (Fig. 1) the neck with the patient in the usual erect posture and having a chain falling naturally just where she desires it (Fig. 2) so long as this remains compatible with surgical requirements. Since I have followed this custom a slender chain has accurately fitted every scar to the intense satisfaction of those chiefly concerned.

2 *Position of patient* In elevating the upper part of the patient's body we are simply taking advantage of an age-old principle calculated to minimize bleeding in the field of operation.

The head is thrown back as far as possible (Fig. 3) without interfering with respiration thus giving the utmost prominence to the tumor and facilitating its ultimate delivery. My attention was long ago attracted to the advantages of this position by C. H. Mayo (8). The head must be raised later on to facilitate closure of the wound else very considerable difficulty may be encountered in handling the structures which have been divided in a transverse plane.

3 *The anesthesia* Various forms of local anesthesia are employed by all of us in selected cases but since the widest requirements will be met by the administration of ether this method only will be discussed here. The employment of the otherwise highly useful drop method has two distinct disadvantages in connection with neck work. (a) The mask is in the way and (b) thorough going asepsis is prejudiced hereby. These disadvantages are overcome by the use of the intratracheal cannula of Meltzer and indeed this admirable idea is almost indispensable in a very few instances where collapse of the trachea is to be feared. For routine practice however a much less exacting technique will answer all the requirements which present themselves in this special field. Two nasal catheters are passed into the pharynx then connected to a glass Y which has its stem coupled up to an ether vapor flask and foot bellows as shown



Fig. 4. The lateral lobes are pulled out of the gland and the superior thyroid vessels divided.

in Figure 4. After the mouth has been closed with adhesive plaster the neck which surrounds the site of operation and covers the patient's body are carried up over the face (Fig. 5) with the result that the operator secures a perfectly free field and gains a singular feeling of security.

4. *Hæmorrhage en masse.* The lateral lobes of the thyroid are exposed in the customary manner by transverse division of the ribbon muscles and if possible luxated out of their beds and the superior thyroid vessel divided thus completely freeing the upper pole (Figs. 6 and 7). I formerly ligated in continuity and at some distance from the gland both inferior thyroid arteries as well as the large vessels entering the lower poles. The first of these two steps endangers the blood supply of the parathyroids and both are wholly superfluous if only a reasonable amount of care be taken with the maneuver to be immediately described.)

Each lateral lobe is next grasped in the plane of intended amputation between the blades of a spring clamp (Fig. 8) and compressed only tightly enough to shut off its blood supply. Sometimes it is necessary to divide the isthmus before such a pedicle can be isolated although this is to be avoided if possible. Care should be exercised to prevent the spring pedicle clamp from slipping back on to the parathyroid and recurrent nerve. This can be accomplished by applying three or four pairs of forceps to the goiter just

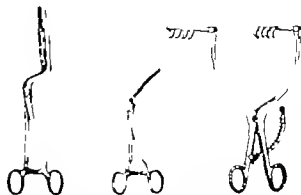


Fig. 5. Clamps used in the technique.

behind the intended plane of compression. The major portion of the lobe is divided from the stump with two strokes of a knife leaving a wedge shaped defect (Fig. 9). This is rapidly closed up with catgut sutures (Figs. 10 and 11) and the compression clamp removed. If the work has been rather accurately done there is usually no bleeding at all or at worst only a very few small points which have escaped notice and are readily controlled by a supplementary stitch or two. The lateral lobule which is reconstructed in this way will of course vary in size with the judgment, experience and inclination of the operator. For reasons stated elsewhere in this paper I incline to remove a very large proportion of any thyroid which is producing toxic symptoms provided of course that I succeed in leaving behind what looks and feels like relatively normal gland tissue. The residuum on either side of the trachea has in my own hands frequently not been larger than a pecan nut varying of course with the original size of the tumor and the character of the material at hand.

5. *Ligation.* Permanent control of the many blood vessels divided constitutes a relatively prominent feature of the goiter technique hence it has been accorded special attention. I have had 10-foot strands of fine catgut coiled up in tubular containers (Fig. 12) having a lateral opening through which it is withdrawn as needed. The package fits snugly in the palm of the left hand and there is no possibility of its contents coming in contact with anything where the loose strand which we have used hereto-



Fig. 9. Two strokes of the knife so as to leave a wedge-shaped defect divide the major portion of the lobe



Fig. 10. Showing stump left after right lobe of thyroid has been cut. B. Operator tying first ligature

fore must necessarily be dragged over the field with the possibility of contamination. Ligature material, handled in this way forms itself into unusually secure knots and does not become soaked in tissue juices therefore does not become slippery. After it is tied and threads cut the short length held in the right hand constitutes the only waste.

Economy in the use of this product becomes at once apparent since a 10-foot strand can be produced at very little more expense than the 5 foot strand in ordinary use. No iodine is employed in the storing fluid for physiologic reasons too obvious to mention.

**6. Wound drainage.** A few operators are sufficiently careful and clever always to leave a goiter wound so dry that it can be closed without drainage. Many others can accomplish the same thing if the patient's welfare is not prejudiced by the length of time required for them to do this. The average surgeon however will experience more satisfaction by draining goiter fields as a routine practice. The usual mid line drain through the original incision practically always produces an inequality of the wound edges. As a rule the upper lip rolls up and while as a usual thing it becomes smoothed out in the

course of months occasionally this deformity remains permanent. In many instances the adhesion which runs directly from the skin to the deepest part of the wound leads to a marked deformity because the tissue planes cannot readily slide over each other. There is at times a deep depression at the drainage point and occasionally tracheal irritation in consequence of the cicatrix having become attached to this important structure.

For a year past I have been draining my goiter wounds through a small split rubber tube which is laid transversely (Fig. 13) across the defect and allowed to emerge at both extreme angles of the incision. Over this are sutured the ribbon muscles high up and in a lower plane the platysma with skin separately. When this tube is withdrawn the skin edges coapt themselves so perfectly that an observer who sees the patient 24 hours later for the first time is unable to tell whether drainage has been employed or not. It is needless to say that no scar at all is left and that the median portion of the wound looks altogether different from those which have been drained in the old way.

The critic might assume on first thought that a tube so placed fails to serve its proper

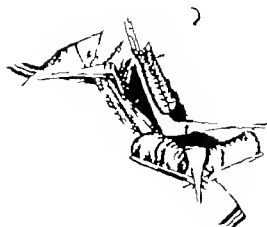


Fig. Following amputation the defect is rapidly closed with catgut suture.

function because it does not lie in the most dependent portion of what is frequently a very extensive defect. However uniformly satisfactory experience has attended the use of such drainage; this is perhaps accounted for by the fact that we can, by changing the patient's position, make any desired portion of the cavity its most dependent one.

My experience with drainage leads me to conclude that where employed at all it should be for a rather protracted period. Some of my patients would have been better off had the drains been left in for one week rather than have been taken out at the end of one day. Somewhere between these two extremes lies the period which will ultimately be determined upon.

7 *Skin closures.* The appearance of a skin scar on the face or neck means so much to a lady that we are justified in minimizing the disfigurement all we can. With this in mind I first sew the platysma accurately and then use for a skin suture No. 0000 Chinese silk mounted on a No. 12 non-cutting cambric needle. These push their way through the skin without cutting and hence create a mark so fine that it can hardly be seen. The thread is left in place only 24 hours if the patient can then bear its removal and no more than 48 hours in any event. The silk has not commenced to cut in by this time unless originally too tightly drawn and the result will surprise the observer who sees it for the first time.

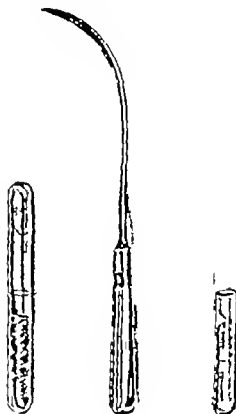


Fig. T-bulb containers with lateral opening through which strands of catgut are drawn.

These tiny needles are so hard to thread that I have had them stamped onto the end of silk strands which are held in readiness for a variety of other purposes too obvious to mention.

8 *Position in bed.* Hypersecretion from the mucosa of the trachea follows gaster operations which entail much handling of this tube. The mucus runs down, accumulates in the lower air passages and is expelled with the greatest difficulty, contributing very largely to the discomfort usually incident to this operation. A surprisingly smooth convalescence can be secured as far as this complication is concerned by putting the patient to bed on her face (Fig. 15) with a pillow under the chest, directly after she is removed from the operating room. If she maintains this position or some slight modification of it for only the first few hours during which hypersecretion is most in evidence the result will



Fig. 13. A split rubber tube is laid transversely across the defect and the ribbon muscles are sutured over it.

as a rule be all that can be desired. The inhalation of steam or very moist air will further contribute largely to her comfort during the 24 to 48 hours which follow her operation.

Twenty six patients operated on in this manner have shown results which in every way approached the ideal. All but one left the hospital very greatly improved as far as concern the symptoms with which they entered. Of course the number is not large when compared with some present day statistics but perhaps there are enough of these cases to furnish suggestions for a future line of treatment. The list embraces every variety of generalized thyroid disease and apparently the operation is equally efficacious no matter what the form of the pathologic lesion.

In no case have symptoms of thyroid deficiency appeared although 18 months have elapsed since the first operation in this series was done. There has not been a symptom of recurrent nerve injury in the list, but three patients may have had symptoms from the parathyroids. One of these three who was operated on six months ago experienced the only wound infection in the list, and after being free from symptoms for four weeks suddenly fell in what her physician considered an epileptic seizure. She has had one of these same attacks every three or four weeks since with suspicious tetanus like closure of the jaws and stiffness in the hands. She has

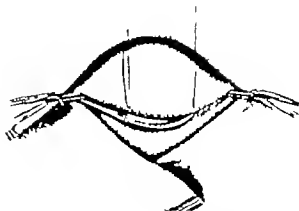


Fig. 14. The platyema is sewed accurately and the skin is closed with a No. 00000 Chinese silk on a No. 12 non-cutting cambric needle.

resisted treatment with calcium salts and parathyroid feeding still to be entirely fair one must consider a possible secondary parathyroid change even though we can positively state in this case that the region in which they are situated was not invaded at all. In a second patient we saw rigidity of the lower jaw muscles and hands ten hours after one of these operations when a large hematoma was discovered deep in the neck. The symptoms promptly disappeared as soon as the blood was liberated. A third patient exhibited trismus for an hour or two the night after her thyroidectomy but has shown no disturbance of any kind up to this time five months later. The only patient in this series who has died



Fig. 15. Shows the position of the patient in bed directly after removal from the operating room.

experienced a post operative psychosis which was fatal eighty two days after the operation. Her complete history follows:

Miss C. No. 6056 age 29 single born in Illinois saleslady by occupation. Patient comes from a neurotic family has two sisters who are insane no goiters or tuberculosis in the family. Previous health had only been fair. She has always been extremely nervous and a definite indication of melancholia was admitted very probably dating from an unfortunate financial affair following the birth of a child seven years ago. Her life has been one of worry.

Upon listing the first her complaint was nervousness she had tremor of only a few months duration palpitation of the heart and tachycardia of a month at onset. During the past month patient had complained of profuse sweating and somnolence. General loss of strength was marked during the last two months. Patient also had a harsh cough with expectoration and a history of frequent sore throat. Natural history was practically negative.

Examination revealed a small woman 5 feet and 2 inches in height and weighing ninety pounds. Her skin was dry and muddy in appearance and gave evidence of pruritus and alopecia. Her goiter was moderately large the right lobe being larger than the left. There was a definite thrill over the arteries on the right side. The voice was normal. There was no evidence of pressure except slight dyspnea. Exophthalmos was not present and the various eye symptoms were entirely missing. Patient had definite tremor. Her heart was violently reactive. Temperature 100 pulse respiration 20 systolic blood pressure 4 haemoglobin 80. Urine was pale in color. Specific gravity 1000 alkaline in reaction with faint trace of albumin. No gallstones.

She entered the hospital and after three days of rest was operated on. Through a short collar incision was removed both halves of the thyroid gland the isthmus as well as the left pyramidal lobe and reconstructed right and left lobules about one half size of the preoperative size using through and through drainage and approximated all divided muscles and skin.

Patient was returned to bed with apparently very little shock from the operation. Regular postoperative treatment of goiter was instituted. During the next few days in hospital she developed

severe melancholia and was frequently entirely irrational. She could not be restrained in her bed at times. Five days after operation the goiter wound had entirely healed and her further stay in the hospital was hastened by days of absolute insanity with short periods of rational behavior. The father took her home three days after operation. Several weeks afterwards we accidentally found her in the observation ward of the city hospital. Where there she was in a semi stuporous condition greatly marked and apparently of no mind. She died nineteen days from the time of operation her death evidently being from extreme inanition.

While subjective improvement has left nothing to be desired in this series still I do not take it into consideration in writing of results since many of my earlier patients subjects of incomplete operations have declared themselves subjectively well though the circulatory and other systems on careful examination were found to be far from normal. However I had never seen rapid pulse high blood pressure etc. return promptly to the absolute normal in a large percentage of toxic goiter patients until I began to perform subtotal thyroidectomy. (Of course one should not expect the repair of permanent anatomic lesions in a long neglected toxic case.) A comparison of the original and ultimate findings in all these cases will be published after more extended observation of the patients has been made.

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A STUDY OF MODERN OPERATIONS IN HYPOSPADIAS FROM AN ANATOMICAL AND FUNCTIONAL STANDPOINT<sup>1</sup>

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**B**y the term hypospadias is meant a deformity of congenital origin due to the absence of some part of the lower or dorsal wall of the urethral canal. The upper or anterior wall of the urethral canal is always present and is represented by a shallow groove or channel on the under surface of the body of the penis. This groove extends from the opening of the urethra behind to the margin of the glans in front where it usually stops short. Occasionally it may be carried through the glans in the form of a fissure or the glans may even be tunneled in a more or less imperfect manner. Three varieties of hypospadias are usually described: (1) the *balanic or glandular* in which the urethral orifice opens just behind the margin of the glans penis; (2) the *penile* in which the urethral orifice opens at some point along the body of the penis in front of the scrotum; (3) the *perineal* in which the urethral opening is behind the scrotum near the site of the central point of the perineum.

*Balanic hypospadias* (Figs. 1 and 2) is comparatively common. It has been esti-

mated that it is present in at least 1 out of every 300 male children. The urethral opening is present on the under surface of the penis just behind the margin of the glans in the place which would be occupied by the frenum if it were present. The frenum and under surface of the prepuce are absent. The lateral and upper surfaces of the prepuce are present and well formed but not redundant enough to cover the glans. The glans is flattened and expanded laterally. It is usually sharply bent at its attachment to the body of the penis so that its under surface is hidden from view. At times the bending of the anterior portion of the penis is so marked that the penis is bound down to such an extent as to be almost concealed by the prepuce and lateral scrotal tissues. The scrotum is usually well formed and the testicles are in their normal position. The orifice of the urethra may be in the form of capacious longitudinal slit or as small as a pin head. In some instances there may be no trace of a urethral canal in the glans. Usually it is grooved or fissured on its under surface. In other cases it may be tunneled completely. As a rule the tunnel is incomplete with its orifice in front or behind.

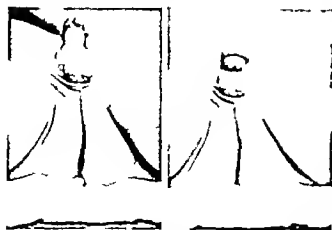


Fig. 1 (left) Balanic hypospadias. Penis held straight and glandular is retracted and urethral opening a short distance behind the glandular margin.

Fig. 2. Balanic hypospadias. Prepuce bowed penis slightly bowed, scrotum well formed, testicles descended.



Fig. 3. Penile hypospadias. Pseudohermaphrodite.



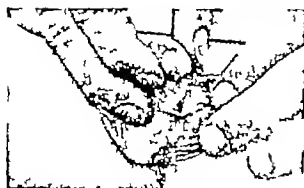


Fig. 4. Penoscrotal hypospadias. (Whit and Martin.)

*Penile hypospadias* is characterized by the presence of the urethral opening along the body of the penis behind the glans but in front of the scrotum. The glans shows all the general characteristics described in the balanic form. The prepuce is well formed and its lateral edges blend with the scrotal tissues behind resembling miniature labia. The penis is often strongly bent at its junction with the glans and the body is bound down to the scrotal tissues. The under surface of the penis in front of the urethral opening is occupied by a groove lined by mucous membrane which stretches forward to the margin of the glans where it usually ceases abruptly. The scrotum is usually well formed and the testicles have descended.

*Perineal hypospadias* is characterized by having the urethral opening situated far back a little in front of the anus (Fig. 3). The scrotum is cleft. The testicles are often retained in the inguinal canal in which event the scrotal tissues are poorly developed and resemble the labia majora of the female. These cases are often mistaken for hermaphrodites or they may be brought up as girls until the age of puberty when male characteristics such as growth of hair on the face and breaking of the voice reveal the true sex. The urethral groove conforms to the type met with in the penile variety. The lateral walls are well developed behind and the sides lie in contact for a considerable distance forming a potential canal. The condition is analogous to the phallic groove met with in the cloacal penis of the tortoise

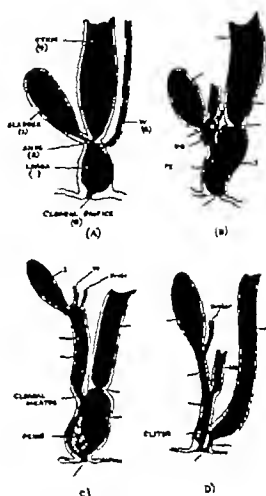


Fig. 5. Diagrams to show the manner in which the cloaca is modified and the termination of the rectum transferred from the cloaca to the perineum in higher vertebrates. A. The amphibian form. B. bladder & oviduct (uter and vas). C. cloaca. D. rectum & uterocloacal anus. E. cloacal orifice. M.D. muellerian duct. B. Form found in the tortoise. C. Form in monotremes. D. Form found in female marsupial. (From Keith *et al.* *Embryology and Morphology*.)

and marsupials. The body of the penis is usually strongly bound down and curved. The glans differs in no respect from the previous descriptions.

In addition to these three forms a *penoscrotal* variety is described where the urethral opening is far back along the penile body (Fig. 4).

#### ETIOLOGY

The cause is to be sought in failure of union of the sides of the genital groove which is present on the under surface of the primi-

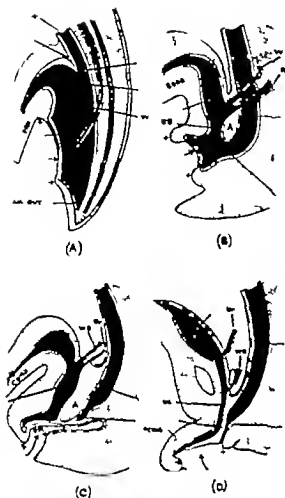


Fig 6 Diagrams showing the manner in which the rectum becomes separated from the urogenital sinus (entodermal cloaca) during development of the human embryo. *A* From the human embryo 4 millimeters long—about 20 days (after Keibel). *B* From human embryo 1 millimeter long—about 35 days (after Keibel). *C* and *D* Later stages of development. 1 bladder; 2 wolffian duct (ureter and vas); 3, entodermal cloaca; 4 rectum; 5 anus; C.M. cloacal membrane; u.g., urogenital sinus; 1 mesoblast at junction of rectum and entodermal cloaca; 2 penis the limits of the penile depression (entodermal cloaca). (From Keith's *Human Embryology and Morphology*)

tive penis. The urethral canal in man is developed in three distinct segments (1) the proximal portion which corresponds to the adult prostatic and membranous portions of the urethra and which is derived from the urogenital sinus of the foetus (2) the penile portion which occupies the body of the penis in front of the membranous part of the urethra and extends forward as far as the posterior margin of the glans penis (3) the glandular portion which results from the tunneling of a special plug of

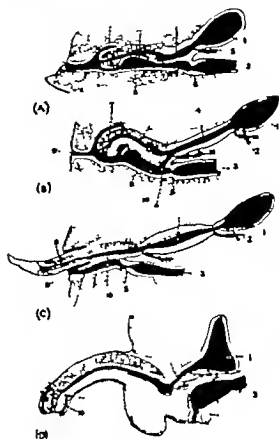


Fig 7 Diagram showing the stages in the evolution of the penis. *A* Stage seen in tortoise. *B* stage seen in echidna. *C* stage seen in marsupial (kangaroo). *D* stage seen in man. The phallic canal is shaded. 1 Bladder; 2 wolffian duct (vas); 3, rectum; 4 phallic groove and canal; 5 phallic canal; 6 floor of phallic canal; 7 Cowper gland. (From Keith's *Human Embryology and Morphology*) The asterisk shows the position of primitive orifice of urogenital sinus.

epithelium which is developed on the under surface of the glans

The various stages in the development will be followed more intelligently if we draw a comparison between the various stages passed through by the human embryo and the conditions present as adult anatomical characteristics in the lower animals. The diagrams shown in Fig 5 represent the various types of cloaca met with in amphibia, *A* in the tortoise *B* in a monotreme (echidna) *C* and in a marsupial *D*. It will be seen that in amphibia *A* there is no urogenital sinus but that the bladder, rectum and wolffian duct (ureter) open by separate apertures into the capacious cloaca. In the tortoise *B* it will be seen that the rectum has shifted its position backward and opens into the upper and posterior part

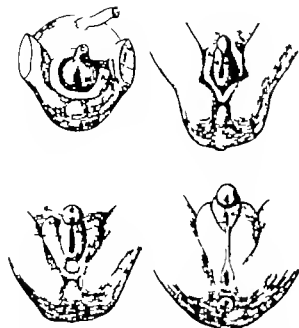


Fig. 5. Diagrams showing the stages in the development of the human penis and perineum. (Drawings by D. Stanley Best, after figures given by Kollman, Keibel and H. Risang.) I. Human embryo, 5 millimeters long (about sixteenth week). II. 20 millimeters long (about eighth week). III. 3 millimeters long (about tenth week). IV. 45 millimeters long (about tenth week). A. Laps of tissue (labia majora). Urogenital orifice being carried to the surface between labia minora. Penis being coming external until urogenital orifice is urogenital meatus.

of the cloaca. Further a constriction has occurred in the anterior and upper part of the cloaca separating from off a bottle shaped cavity (urogenital sinus) into which

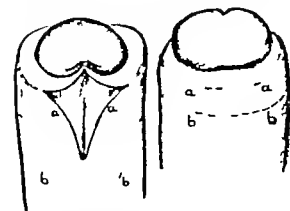


Fig. 6. Drawing illustrating the Russell Duplay technique. Full description in text.

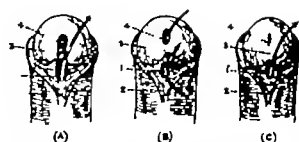
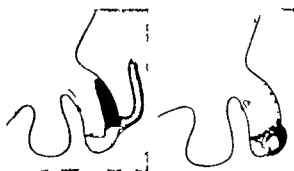
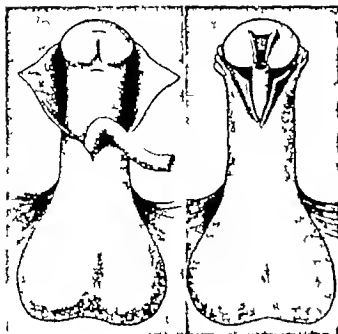


Fig. 7. Diagrams showing three types of hypospadias. (A) Type in which the groove in the phallus (phallic groove) is open and urine passes by the urogenital orifice. (B) Type in which the floor of the phallic groove is formed, but the urogenital orifice is unclosed. (C) Type in which the phallic groove is formed, obliterated, and the urogenital orifice serves as meatus. Urogenital orifice 2, frenum 3, prepuce 4, phallic groove 5, and nail 6, permanent meatus.

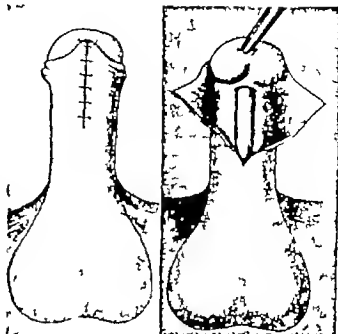
open the bladder and the muellerian and wolffian ducts. Into it also opens the ureter which is a new development. In the monotreme echidna the urogenital sinus into which open bladder, ureter, wolffian and muellerian ducts has become greatly elongated and opens into the upper and anterior part of the cloaca as in the tortoise. The rectum has approximately the same position. In marsupials the urogenital sinus does not differ in any important particulars from that in echidna. The rectum however has migrated so far backward and downward that it opens into the cloaca very close to the cloacal membrane as near the perineum. The cloaca is much less capacious than in B and C, and at its upper end the urogenital sinus and rectum enter by separate openings placed close together. If one compares these figures with the series of human embryos



Figs. 8 and 9. Drawings illustrating the M technique. Full description in text.



Figs. 13 and 14 Illustrating Beck technique



Figs. 5 and 6 Illustrating Beck technique

(Fig 6) it is clear that *A* of the human embryo series showing a section of a fetus of about 20 days is in the stage of adult amphibian development that *B* representing a fetus of about 35 days is in the stage of an adult tortoise or monotreme and that *C* representing a fetus of a later age is in the stage of an adult marsupial.

Up to the present we have traced the development of the urogenital sinus which becomes the permanent prostatic and membranous urethra. In order to understand the development of the penile portion of the urethra it will be necessary to follow the stages in the development of a penis in the lower animals and its gradual evolution to the type found in the higher mammals. The following set of diagrams (Fig 7) represent the stages seen in the evolution of the penis. In the tortoise *A* in a monotreme (echidna) *B* in a marsupial *C* and in man *D*. In the tortoise and echidna the penis is completely intracloacal in marsupials the penis is partly intracloacal in man the penis is entirely extracloacal. In the tortoise (1) the urogenital sinus opens into the cloaca at the posterior end of the penile eminence. From this opening the under surface of the penis is occupied by a longitudinal groove

(phallic groove) which passes to its end. During copulation this groove is converted into a canal by contact with the posterior cloacal wall. In echidna (*B*) the phallic groove has been converted into a canal except at its hinder end where the urogenital sinus opens into the cloaca. In marsupials (*C*) the hinder end of the phallic groove in the penis has been transformed into a canal which is continuous with the urogenital passage. The urethra opens into the cloaca about half way along the body of the penis. The under surface of the organ in front of this opening is occupied by a deep phallic groove which passes almost to its end. In man *D* the whole length of the phallic groove has been transformed into a canal which reaches (in the illustration) to the posterior margin of the glans. Further the rectal orifice and urogenital sinus have been still further separated from one another by the growth of the perineal body. A further comparison between *C* and *D* shows that in marsupials the penis is partly intra and partly extracloacal whereas in man the penis is entirely extracloacal. In man the migration of the rectum backward and the downward growth of the urorectal septum which practically separates the cloaca into

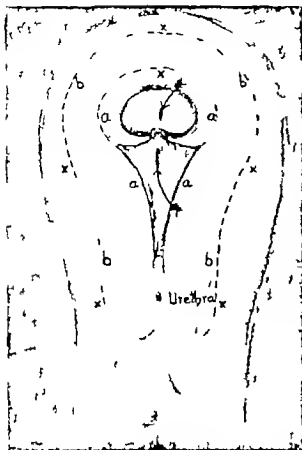


Fig. 7. A thoracic modification of Russell method

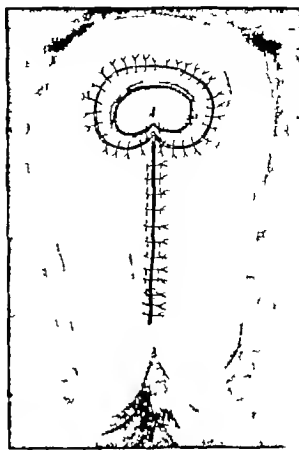


Fig. 8. Drawing showing the final result after thoracic method

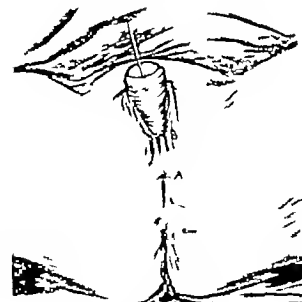


Fig. 9. Final result in Case

two cavities forces the genital eminence into an extracloacal position. This is seen very clearly by a study of *B* and *C* (Fig. 6) in which the transition from *B* to *C* seems to have been effected by the growth downward of the urorectal septum. In *C* the cloacal membrane *c* is still present, separating the cloacal depression (ectodermal cloaca) from the primitive cloaca (entodermal cloaca). The urorectal septum is in contact with the cloacal membrane and has separated the urogenital sinus in front from the rectal passage behind. The urogenital sinus has also sent a process into the genital eminence. At a later date the cloacal membrane breaks down and the urogenital sinus opens into the ectodermal cloaca and still later with the further growth of the urorectal septum downward the urogenital sinus opens on to the perineum.

The stages of development of the *penile urethra* can be followed easily from this point on (Fig 8). In the perineum about the end of the seventh week a circular fold (the cloacal or outer genital fold) can be seen *I A* which forms the boundary of the ectodermal cloaca. Within it can be seen the genital ridge or eminence which is grooved on its under surface (cf the tortoise). This eminence forms the penis or clitoris. The groove (phallic) passes backward as far as the opening of the urogenital sinus. In front it does not reach the end of the primitive penis but stops just behind the glans. In *II* (a stage about the end of the second month) the edges of the groove in the genital eminence called urethral or inner genital folds *a a* have united in their posterior portions and in so doing have shut off the posterior (anal) from the anterior or urogenital part of the ectodermal cloaca. In front the groove is still open. In *III* (about the beginning of the third month) the posterior ends of the united inner genital folds *aa* have fused with the contiguous sides of the outer genital folds *4A* except behind where the anal opening *F* comes to the surface. The inner genital folds meet behind to form the penneal body. In front they meet on the under surface of the glans. Between these points the penile groove is still wide open. In this stage the male and female organs are alike. If the female type persists the inner genital folds remain open as the labia minora. If the case develops up to the male type they unite to form the penile urethra. In *IV* (fœtus about the tenth week) the inner genital folds (urethral) have united except just behind the glans. The outer genital folds (cloacal) have also united over them and by their fusion produced the median raphe of the perineum and penis forming the labia majora in the female and the scrotum in the male.

The glandular portion of the urethra is formed by a separate process. On the under surface of the glans a crest of epithelium makes its appearance. This becomes changed into a gutter (phallic groove) and finally by fusion of its edges it becomes transformed into a canal which in the adult and perfect

condition unites with the penile canal behind. In *III* Fig 8 the glandular groove is shown unclosed and is continuous with the penile groove. In *II* the margins of the phallic glandular groove have united but the channel is not continuous with the penile urethra which ends just behind the glans a condition quite common in the balanic type of hypospadias. Failure of regular canalization of the ectodermal plug that forms the glandular urethra is responsible for the numerous varieties of grooves and channels that have been met with in the glans when the urethra opens behind it (Fig 9).

#### INDICATIONS FOR OPERATION

Cases of the *perineal variety* with undescended testicles are both sexually impotent and sterile. There can be no real reason apart from sentiment to advise an operation because even if successful it would accomplish nothing more than to enable the patient to urinate in a standing posture as other men do. On the other hand where we are reasonably sure that sexual powers are likely to be present the operation is not only justifiable but imperative. In the *balanic variety* we may reasonably doubt the propriety of operating except in carefully chosen cases. There is abundant proof that coition though hindered is quite possible and that impregnation is frequent. Cases in which the penis is reasonably straight and well formed should not be operated upon. Where there is much deformity from bowing the penis should be straightened and if necessary a new urethral canal made. Surgical procedures in cases of *penile or perineosrotal varieties* are always justifiable.

*Suitable age for operation.* The most suitable age is from the sixth to ninth year. The patients are then old enough to be controlled and to give material co-operation in the after treatment but they are not old enough to be troubled with erections from sexual irritation.

#### OPERATIVE PROCEDURES

These may be considered under two headings (1) those having as their object the liberation and straightening of the

penis (2) plastic procedures for the purpose of making a new urethra

*Straightening the penis* In the balanic type with a moderate amount of bowing of the penis it can be straightened by a procedure familiar to all surgeons in the operation of pyloroplasty. A transverse incision is made on the under surface of the penis just behind the glans and in front of the urethral opening. As the transverse cut is deepened it becomes transformed into an oval or more strictly speaking in this position it becomes roughly kite shaped with the point toward the urethral opening (Fig 10). If the sides of the kite shaped area are now approximated the line of suture will be vertical and the bowing will disappear. In cases of severe bowing this operation should be completed before any plastic work is attempted on the urethra. In mild cases we may continue with the plastic work at once. If the bowing is to be corrected completely the transverse incision must be deep enough to divide every structure as deep as the corpora cavernosa. Complete liberation means a large wound and when the sides of the wound are approximated the urethral orifice will be found to have receded from the margin of the glans to an alarming degree. It is however the most necessary part of the operation if a straight, useful penis is desired.

*Making the new urethra* It should be laid down as an axiom that no skin should be employed as a urethral flap which contains hair follicles because serious trouble will follow sooner or later from phosphatic deposits on the hairs. Happily there is plenty of skin free from hair that can be obtained from the lateral aspect of the penis while the hood of the prepuce is absolutely free from this objection. Skin flaps taken from the lateral aspects of the scrotum should be avoided.

It will simplify our description if we divide the operations into two classes first, those on the balanic and anterior penile varieties and second those on the posterior penile and perineal.

1. *Operations on cases of balanic and anterior penile forms of hypospadias* Two

types of operation have been employed (1) the employment of flaps obtained from the prepuce and the side of the penis and (2) dissection of the urethra from its bed followed by its advancement through a tunnel perforated through the glans penis.

*Flaps taken from the prepuce and penis* There are two types of this operation. In one the pedicle of the single flap is above on the dorsum of the prepuce (Mayo) in the other the pedicle of the two flaps are below on the sides of the penis (Russell Duplay).

The former operation usually known as the Mayo procedure is performed as follows (Figs 11 and 12). First the penis is straightened by the procedure described previously and the wound is allowed to heal completely and to consolidate. At the second operation a capacious tunnel is made through the glans penis reaching from its end to a point a little to one side of the urethral opening. Then a right angled flap long enough to reach without tension through the tunnelled glans to the urethral opening is cut from the skin of the dorsal surface of the prepuce and penis. Its base is in front near the free margin of the prepuce, its apex is behind near the root of the penis. It must be wide enough to be rolled up into a little tube like a cigarette paper. After dissection it is rolled up with the skin surface inward and the edges are united with fine sutures of chromic gut. The tube is then dragged through the tunnel in the glans and its apex is stitched to a bed prepared for it in close contact with the site of the urethral opening. Nothing further is done in this stage of the operation. Subsequently when the tube has healed in its bed, the preputial attachment is severed. At a later operation the proximal end of the tube is united to the end of the urethra.

The latter operation (Russell Duplay) is performed as follows. The penis is straightened at a previous operation. First the bladder is drained by inserting a self retaining catheter through a perineal puncture. Then two lateral flaps are cut from the sides of the penis and prepuce. The bases are below and encircle the urethral opening. The apices are above on the dorsum of the

prepuce. The flaps consist of skin and subcutaneous tissue. They are free at their apices and as far backward as the under surface of the glans but from this point backward to the urethral opening the lateral margins are dissected up as little as possible to conserve the blood supply. The lateral margins are then united together with fine chromic gut sutures and the mesial edges of the free ends of the flaps similarly fastened together. The tube which results is then pulled through a tunnel made through the glans penis as described in the previous operation and its apex sutured in place. Figure 10 shows clearly the method of cutting the flaps. In the figures the apices of the flaps have been outlined on both the under surface of the penis and the dorsum of the prepuce. When dissected up the anterior end of the flap looks like a clergyman's stole.

*Dissection of the urethra from its bed followed by advancement through the glans* (Beck's operation). This operation has enjoyed great popularity on account of its apparent simplicity. It is performed as follows. An incision is made around the urethral orifice and if necessary a vertical cut is carried along the under surface of the urethra towards the perineum. The urethra with the spongy body is now dissected off from the corpora cavernosa in the form of a tube until it is long enough to be drawn through a tunnel which has been made through the glans by a stab puncture. The advantages of the operation lie in its simplicity and in the slight risk of failure from non union or from necrosis of the urethral tube. It should only be attempted in cases of the balanic type and in those varieties where the penis is straight and not bound down. If attempted in cases where the penis is strongly curved and bound down, dissection of the urethra will allow the penis to be straightened out but if the urethra is brought through the tunnelled glans the curve of the organ will be reproduced and a functional failure will result. The steps of the operation are shown in Figures 13 to 16.

Of the operations described above preference must be given to those which employ

the skin of the prepuce and penis as flaps. And perhaps the safest is the one where the flaps are taken from the dorsum of the penis and prepuce (Mayo) because they are better nourished at the base. In the flap operation with the pedicle below (Russell Duplay) the defect can be remedied in a one stage procedure if a penneal puncture is made and the bladder drained. When the flap is taken from above a two-stage operation is always necessary because it is practically impossible to obtain union between the ends of the cigarette flap and the urethra at the first operation. Beck's operation must be reserved for easy cases with little penile deformity.

It is so important to keep the field of operation free from contact with urine that drainage of the bladder through a penneal or suprapubic opening is a necessity in every type of operation except Beck's. In one stage operations and the second phase of two-stage operations failure is almost certain to follow any attempt to drain the bladder through the new canal.

Penneal drainage can be used in cases of the balanic and most of those of the penile variety. A self retaining catheter should be inserted into the bladder through the penneal puncture. Its end should be just within the vesical orifice. To prevent slipping it should be stitched to the skin of the perineum. At the same time the anterior urethra in front of the penneal opening should be drained with a small rubber gutter or a few strands of horsehair to remove any urine which leaks outward from the bladder alongside the catheter. This precaution is quite necessary to prevent troublesome complications because after the catheter has been retained a few days there is an irresistible tendency for the urine to escape alongside it. In the penneal and perineo-scrotal varieties suprapubic drainage is necessary. It is usually a very easy procedure. The bladder is distended with fluid and a puncture made into it with a large trochar and cannula. A catheter is passed into the bladder through the cannula which is then withdrawn. Care must be taken to make a number of large fenestræ in the



catheter and not to allow the end to reach the region of the trigone where it would cause constant irritation.

*B Operations in the posterior penile and perineal varieties.* In operating by ordinary methods at least three operations are required to effect a cure. In the first the penis is straightened in the second the penile defect is closed except at the urethral orifice in the third the urethral orifice is closed. In making the new urethra the type of operation which gives excellent results is one in which the urethra is fashioned from lateral flaps which are taken in front from the prepuce and behind from the sides of the penis. If the urethral opening is very far back scrotal tissue must be employed to a slight extent. The operation that has appealed to me as the best was described by R. H. Russell in the *British Medical Journal* of November 17, 1900. Posteriorly flaps are taken from the tissues on either side of the urethral groove and are fashioned according to the method of Duplay. In front they are taken from the sides of the penis and the dorsum of the prepuce. As performed by Russell the operation is divided into two stages. In the first stage the penis is straightened and the urethral canal fashioned but no attempt is made to close up the urethral opening. A few months afterward the posterior and anterior urethra is joined by a plastic operation on the urethral opening. I have modified the Russell method in some particulars and the following is a description of the operation as a one stage procedure. Figures 10 and 17 show the method of cutting the flaps. Figure 10 represents an anterior penile. Figure 17 a posterior penile variety. A transverse incision is made through the under part of the penis behind the glans (frenum?) and carried around the penis dividing the prepuce about one eighth inch from the corona *a a a a*. By deepening the transverse cut underneath the glans the penis can be gradually straightened. The liberated organ viewed from its under surface then looks like the drawing, the shaded area representing the raw surface the shape of which is roughly triangular or kite-shaped. A capacious channel is now

made through the glans by transfixing it with a narrow bladed knife from its dorsum to the middle of the broad area of the triangular wound. A second incision *b b b b b* is now made in the skin of the penis beginning at a point about one third to one fourth inch to the lateral margin of the urethral opening. (If a one stage operation is contemplated the incision begins about one eighth of an inch behind the urethral opening and is curved backward and outward around the urethral opening before pursuing its lateral course.) It is carried forward parallel to the side of the urethral groove behind and the margin of the raw triangular surface in front. It passes over the dorsum of the prepuce from one side to the other parallel to and behind the cut previously made and is carried down the other side of the penis parallel to the raw surface and the urethral groove to a corresponding point on the opposite side of the urethral opening. The distal part of this incision is parallel to and behind the first cut made through the prepuce for the purpose of liberating the penis and both incisions result in fashioning a flap of prepuce which is shaped exactly like a clergyman's stole. The flap so outlined which is about one-quarter inch wide, is raised up care being taken to preserve its vascular supply. It is not advisable to separate the outer edges of the posterior extremities of these flaps too extensively from the penile bed, because the vitality of the whole flap will be imperilled. The skin surfaces of the flaps are now turned face to face and the corresponding edges united carefully from end to end with sutures. I have used chromic catgut (No. 00) for this purpose and have employed a continuous suture reinforced by a few interrupted sutures applied in such a manner as to turn the skin edges inward toward the lumen. Russell does not believe that it is necessary to suture the edges together so carefully. He uses a few sutures to unite the edges of the anterior free part of the flaps. In the under part of the flap he uses no sutures in the inner edges, which he asserts will come together when the operation is completed. He fastens the outer

edges together by the same stitches that are used to bring the margins of the penile skin together over the newly fashioned urethra. This method of suture did not please me because it brought the line of the urethral directly under that of the skin union and any infection of the skin margin with failure in primary union would be fatal alike to the urethra.

The tube formed in this manner is now drawn through the channel previously tunneled through the glans and fastened in place by a fine point of suture. The final stage of the operation consists in burying the new urethra. This is done by uniting the margins of the skin of the sides of the penis to one another over the urethra. This is done from behind forward until the urethral tube is covered as far as the lower margin of the glans. From this point forward and over the dorsum of the glans the preputial skin margin outside the stole flap is united to that left attached to the glans inside the stole flap. In Figure 17 the parts marked by the letters  $x$  and  $x$  on opposite sides of the penis and on the dorsum of the prepuce are brought together. The parts corresponding to the middle  $x$  and  $x$  on a level with the lower arrow are united with the prepuce (where the frenum would be) marked  $xx$ . The final result is represented in Figure 18.

I have employed the Russell method of operating in two cases with excellent results.

In one a boy of 9 years of age, I succeeded in making a new urethra in one sitting. The urethral opening was situated in the posterior portion of the penis. The penis was tightly bound down and bowed. The bladder was drained by a catheter inserted into it through a suprapubic puncture. The operation was performed exactly as outlined in Figures 17 and 18. The result was primary healing. The patient left my care at the end of two weeks with the suprapubic opening still draining. Unfortunately I have never been able to trace the patient.

The second case a boy aged 7 years was one of the perineoscrotal variety. The urethral opening was a little in front of the central point of the penneum. The operation was divided into two stages. In the first stage the anterior urethra was fashioned according to Russell's method. The bladder was drained by a catheter passed through original the urethral opening. Unfortunately the

part of the new urethra that was drawn through the glans died and the result was that the new urethra opened a little distance behind the glans. The second operation performed a year afterward was preceded by a suprapubic puncture and drainage. The perineal opening of the urethra was then closed by a procedure exactly like that employed for many vesicovaginal fistulae. Afterward the anterior urethra was elongated by a plastic procedure similar to that in the first operation, the flaps being taken again from the prepuce. As we could not get enough tissue to form a tube long enough to bring through the glans we were content to fashion it as far as the posterior margin of the glans. The result was very satisfactory. The catheter drained the bladder perfectly for 6 days. After this a little urine would escape along the urethra causing a considerable amount of pain. At the end of 10 days it was removed and all the urine passed along the penis. The result was very gratifying. Urination was painful but at the end of three weeks, the patient was discharged in excellent condition. I have heard since 5 months afterward that urination is free and although attended still by a little pain the discomfort is gradually disappearing. In this case although the urethra is not placed at the end of the glans, the penis is straight and of fair length. There are fair prospects of a useful organ resulting. Figure 19 a composite photograph and drawing represents the condition of the penis at the present time.

A case was recently under my care in a young negro aged 14 where the plastic work on the anterior part of the urethra was ruined in two successive operations by the penis becoming erect during convalescence. The penis was strongly bowed down and acutely curved. The urethral opening appeared to be placed about the middle of the body of the penis. The glans penis showed a slight phallic groove. There was abundant preputial tissue. The testicles had descended and there was a fairly well formed scrotum. At operation the bladder was drained through a perineal puncture. The penis was liberated by a transverse cut through the spongy body behind the glans and in front of the urethral opening. The resulting incision was deep and wide and the raw surface kite shaped and of unusual length owing to the excessive curvature of the penis. When the penis was straightened, the urethral opening was found to correspond with the root of the organ. Flaps were thrown up according to the method described by Russell. When applied together the resulting tube was not long enough to reach through the glans without reproducing a considerable amount of curve. It was decided not to tunnel the glans but to stitch the end of the tube to the under surface of the margin of the glans as a straight long penis was more desirable than a long urethra. On the second day an erection occurred which broke down the union of the anterior third of the wound. A few days later some urine made its way along the

newly formed urethra and caused its posterior end to break down.

Five months later the patient returned and I found the following condition. The urethral opening was represented by an oval aperture about one sixth of an inch long at the root of the penis. In front of this was fully an inch of reconstructed urethra in excellent condition. In front of this again to the end of the penis, the urethra was wanting. At the second operation the bladder was drained by a suprapubic puncture. The posterior opening leading to the urethra was closed by the simple plastic procedure of circular incision

followed by suture of the inverted skin edges. The anterior urethra was remade by flaps taken from the sides of the penis by the method of Duplay. No attempt was made to tunnel the glans penis. Convalescence was good until the third day when an erection occurred and the wound immediately behind the glans broke down. The site of the posterior plastic work remained in good condition and healed completely. The final result was that we lost about half the length of the anterior plastic work. At present the penis is quite straight and long and the urethra opens about half an inch behind the glans.

## CONSERVATIVE FOOT SURGERY

### WITH REPORT OF A CASE<sup>1</sup>

BY JOHN PRENTISS LORD, M.D. F.A.C.S. OMAHA, NEBRASKA

FOR many years I have contended that practically all of the ancient classical tarsal amputations (with all due respect to their distinguished authors) were unworthy of the space that they continued to occupy in stereotyped textbooks. The dictum as set forth by Agnew, Guerin and Mayer<sup>2</sup> that the bones of the foot should be considered one and divided by the saw at such point as to conserve the greatest amount of foot and function is correct. This method has been followed by me for nearly a quarter of a century. For years men have been using old time worn methods intent on getting flaps to cover and have been sacrificing the skeletal structures with everlasting loss to the patient just because a doctor is so busy in the study of the anatomy and in the pursuit of a technical amputation (following the masters).

In my early years in surgery I made the claim that skin defect was not the determining factor in foot amputations. I skin grafted or subsequently covered with flaps from the other leg feet deficient in skin covering and thus saved practically all of the solid structures of feet, not actually devitalized by crushing or mutilating injuries. Bone defect should no longer be a cause for amputations except perhaps in exceptional

cases. Lack of blood supply is in the final analysis practically the only indication for amputation if we properly apply present-day knowledge. This is even more true today, and should be emphasized since the added experience from the European war. These remarks are a repetition of my early teaching. I believe that time and our present advancement strengthen my position on the subject of emergency amputations in general. The number of primary amputations therefore should be greatly lessened.

The writer has been free to state, in his later years that the majority of operators do not know their limitations. This is too conspicuously true in amputations.

I am quite confident from present-day textbook knowledge and in the hands of the vast majority of operators such as handle cases like the following, that this foot would have been amputated.

While rabbit hunting in November 1914, a lad of sixteen was accidentally shot in the right foot by his companion, the muzzle of whose gun was about eighteen inches distant. The charge of No. 4 shot carried away nearly the entire thickness of the Achilles tendon, the posterior tibial group of tendons, the artery vein and nerve, together with the internal malleolus, inner half of the astragalus, a portion of the scaphoid and the distal portion of the tibialis anticus tendon, and all of the skin fat fascia,

<sup>1</sup>Matas, Park. Surgery

<sup>2</sup>Read before the Western Surgical Association, St. Paul, December 1914.

and ligaments in the path of the charge leaving an excavated trough through the structures mentioned. There was little hemorrhage.

The wound was antiseptically dressed by the attending physician, Dr. Kalar of Bloomfield, Nebraska, who called me in consultation. At the forty-eight hour period when first seen the wound was clean though blackened. Any loose shreds of tissue left by the clean cut effect of the charge had been removed at the first dressing. To avoid amputation was the first thought of all concerned. The difficulties in saving the foot however were fully appreciated by the attending physician and the consulting surgeon. Successfully to combat the results of an impending infection in this open wound with all of its exposed cartilage, bone, ligaments, nerves and tendons was our problem. The first step was to minimize the extent and the effects of sloughing and suppuration. We therefore cut away every shred of tissue that we thought would not remain vitalized. The ligaments were very closely trimmed and the tendons were picked up and pulled out until the uninjured portions appeared when they were cut off and allowed to retract within their sheaths the collapse and healing of which would stop otherwise inevitable infection and sloughing the occurrence of which would mark the beginning of probable disaster. This forestalling of infection in the soft parts, however, did not remove the danger from the inevitable devitalization of the cartilaginous surfaces exposed in the wound.

The case was brought to the Clarkson Hospital, Omaha, on the fourth day. The implantation of an attached graft of skin, fat, and periosteum covered bone from the tibia of the other leg, was considered as a means of filling this unusual excavated wound. This plan was rejected on account of the greater probability of deep infection in the inevitably devitalized cartilages, in a closed and covered wound, and so inviting involvement of the remaining tarsal joints. The plan adopted seemed to offer less possibility of deep infection. This decision was the outgrowth of the writer's very considerable experience with astraglectomy for the correction and stabilization of various classes of extreme club feet. The outer remaining half of the astragalus was excised December 10, 1914 and the cartilagi-

nous surfaces were removed from the tibia, fibula, scaphoid, cuboid and os calcis the external malleolus was shortened and the os calcis gouged on its outer superior surface to allow the malleolus to rest one-half inch forward of its normal position and thereby produce a more shapely and probably more useful foot, as recommended by Whitman, who originated a similar most valuable operation for talipes calcaneus. When the tibia and fibula were brought in contact with the os calcis the original wound on the inner border of the foot was almost closed. The parts were stabilized by a temporary twelve-penny wire nail driven through the os calcis into the tibia. The foot was further fixed by a plaster dressing. Healing was uneventful. The nail and the plaster were removed one month later and a lighter cast worn for four months.

At this stage much of the hyperemia and swelling had subsided and the final stage of the operative plans was carried out. The course of the former wound was laid open and extended up the leg and forward beyond the scaphoid. The Achilles was spliced by tenoplasty, fortified by sutures of silk and the posterior tibial tendon was restored in a similar manner. The flexors were not restored. The tibialis anticus was. The two and one half inches defect in the posterior tibial nerve was restored by splitting one-half the nerve for about 3 inches from the proximal end which was turned downward and united to the freshened end of the distal portion. A new bed in fatty tissue was made to avoid the subsequent involvement of the nerve in cicatricial tissue. The other repaired structures were similarly protected. Aside from some marginal necrosis of former scar tissue there was ultimate sound healing. For more than a year there has been good use of the foot. Sensation has returned except in a small area on the heel. A trophic ulcer, on the under surface of the heel, at the site of the incision for the nail has been rather persistent but is now healed after the use of a pad of felt so trimmed as to remove point pressure in parts attenuated from deficient innervation. The limb is five-eighths of an inch short. The deficiency is partly corrected by a generous felt pad under the heel and two extra lifts on the heel of the shoe. The young man's walk is characterized by a very slight limp due to a stiff ankle but there is no pain.

## CAISSON BRONCHOSCOPY IN LUNG ABSCESS DUE TO FOREIGN BODY

BY CHEVALIER JACKSON, M.D. F.A.C.S. PHILADELPHIA

THE simplicity and ease with which in most instances recently inhaled dense foreign bodies may be removed from the larger bronchi by bronchoscopy deprives such cases of interest warranting their publication save directly for statistical purposes. The introduction of the bronchoscope requires but a minute and the removal of the foreign body but a few minutes more. There are three classes of cases however in which the difficulties of removal are exceedingly great and in a few instances may even be insurmountable. The three classes are

1 Cases in which the size, shape, density or location of the foreign body present mechanical problems in the disimpaction and removal of the intruder.

2 Cases in which ill advised efforts at bronchoscopic removal have complicated the removal by (a) forcing the foreign body tightly down into small bronchi (b) causing intense local reaction by rough manipulations ending in the edematous proximal closure of the invaded bronchus or (c) ultimately fatal mediastinal complications.

3 Cases in which the prolonged sojourn of the foreign body in the lung has resulted in secondary inflammatory changes such as (a)

proximal stricture (b) exuberant granulations (c) abscess (d) firm fibrous partial or complete enclosure of the foreign body.

It is in the latter class that the case here recorded belongs and a brief note of accepted facts relative to this class is necessary. In this class of case the difficulties of removal are enormously increased by the quantity of pus stained with blood that constantly obscures the field. It does not lessen the illumination but being opaque it is impossible for the human eye to see through it hence it must be removed. If the pus were contained in a single large cavity or even a number of such cavities removal would be easily accomplished by an aspirating tube contained in the wall of the bronchoscope or by an independent aspirating tube inserted through the bronchoscopic lumen but unfortunately cough is a very inefficient remover of secretion and moreover in these cases of prolonged sojourn the ciliary action is impaired or absent. Therefore the pus is contained in hundreds of small bronchi constituting drowned lung. This pus is continually by respiratory or hectic movements being forced into the field of vision. In some instances a wedge shaped area of lung is drowned by the foreign body acting as a

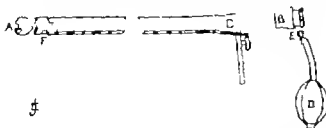
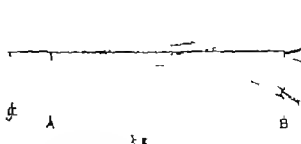


Fig.

Caissou bronchoscope. When the window-plug B is inserted in the proximal tube mouth C the operator can with the bulb D readily raise a moderate positive pressure in the bronchoscope; the distal end F of which is inserted through the strictured orifice of the abscess cavity. The secretions, edematous granulations, etc. are forced outward permitting the inspection of the interior of the abscess cavity. The alve E was intended to retain the plus pressure but in use it was



found that the alve constantly escaped along the pus at the neck of the cavity.

The malleable-ended bronchoscopic forceps. The portion A to B is made of low brass or copper so that it may be readily given any shape desired. Useful in reaching around the corner and when a sidewise direction of movement cannot be imparted to straight forceps by the bronchoscope.



Fig. 3. Roentgenogram showing corroded steel pin in the lung of a woman aged 63. The pin had been in the lung for five years.

cork in occluding the bronchus to which the wedge is tributary. In such instances the slightest manipulation of the foreign body is immediately followed by a flood of sanguinolent pus which covers the field with an opaque cover through which no light can penetrate and no eye can see. The most rapid method of removal is by the author's sponge pumping process. This procedure is as follows:

A gauze sponge on a bronchoscopic sponge carrier is pushed down until the sponge emerges from the distal end of the bronchoscope. The patient is then requested to cough which fills the bronchoscope with the secretions. Then the withdrawal of the sponge pulls out ahead of it the entire contents of the bronchoscope. This method has the advantage that the cough not only forces into the bronchoscope the pus covering the held but it also squeezes out the secretions in the area of drowned lung that would otherwise come into the field immediately upon the next attempt to work. The foregoing brief résumé is essential to the understanding of what follows.

Fig. 4. Crumbs of corroded steel pin removed from a lung abscess evacuated by bronchoscopy through the mouth under local anesthesia.

CASE No. Fbdy 569. A woman aged 63 had lost a pin down her throat five years previously. For a time there were no symptoms. Then gradually increasing cough set in, with later foul and occasionally blood-streaked expectoration. Bronchoscopy previous to coming to our care had been unsuccessful in finding the pin.

*Roentgenologic report of Drs. Johnston and Grier.* Fluoroscopy negative. Roentgenography showed (Fig. 3) a very vague shadow of a pin in the right lung about on the level of the center of the heart shadow. The pin is evidently surrounded by inflammatory tissue. Its direction is about 25 degrees from the horizontal; the point is higher and nearer the median line than the head. There is an enlargement of the heart and a diffuse dilatation of the aorta, probably an aneurysm though not sacculated.

*First bronchoscopy.* Local anesthesia. The right main bronchus and the visible part of its branches showed the usual signs of prolonged chronic bronchitis. The odor exhaled through the bronchoscope was of the stale, putrid odor characteristic of the long-continued saprophytic action in all cases of prolonged sojourn of a foreign body in the lung. Nowhere was there any sign of trauma from the evidently carefully done bronchoscopy by my predecessor in the case. Just below the orifice of the middle lobe bronchus, pus was seen oozing during expiration, squirting during coughing from an orifice about 2 millimeters in diameter. This orifice was dilated with the author's bronchoscopic dilators bringing into view a black object about 2 millimeters in diameter, evidently the pin seen on end. Crumbs of black, gritty material came away on the bronchoscopic sponges. The end of the pin was grasped with the plain bronchoscopic forceps and gentle traction was made. There was not enough cohesion of the steel pin, corroded by its five years' sojourn, to enable withdrawal. Successive bits were brought away as traction parted the piece held in the forceps from that remaining behind as if the material were charred toast. At length no further fragments could be found though the head had not been removed. Black crumbs, like ground black pepper, could be seen scattered over the vicinity of the orifice of the abscess cavity and over the sponges used to wipe the interior of the cavity. The use of the word "cavity" is however somewhat misleading as the interior was completely filled with a mushy, edematous mass of flabby granulations. As the patient had coughed many times in response to requests, and in view of the dilated, probably aneurysmal thoracic aorta, it was decided to desist pending further roentgenography and study of the problem of removal of the head of the pin. Duration of first bronchoscopy, 3 minutes 15 seconds.



FIG. 5. Roentgenograms, anteroposterior and lateral showing bronchoscope and forceps in relation to the head of the pin remaining after bronchoscopic removal of the corroded shaft.

*Second roentgenography.* The roentgenogram showed the head of the pin with the minute fragment of the shaft embedded in it located downward and toward laterally from its original location. This change of position showed clearly that the head of the pin was free to move in a cavity because the extremely gentle manipulations (bronchoscopy) had been insufficient to force the head into any tissue. But it was known from the previous bronchoscopy that this cavity was in a sense collapsed upon its contents of edematous, mushy granulations.

In discussing with the roentgenologist, Dr. George C. Johnston the problem of finding the head among this mushy material the idea of the calisson bronchoscope (Fig. 1) was evolved. This consisted of a self-illuminated bronchoscope of small diameter the proximal end being occluded with a window plug removable at will the plug being furnished with a side outlet with which a small rubber hand ball was connected. By this means a positive pressure could be created in the tube and released at will. The first instrument was made by remodeling the author's inner bronchoscopic tube (*Tracheobronchoscopy* Fig. 42).

*Calisson bronchoscopy.* Under local anesthesia the orifice of the abscess cavity was located with the 9 millimeter bronchoscope and was found to have closed slightly from its dilated diameter. The sanguinolent pus was got rid of by sponge-pumping and the bronchoscopic dilators were used again until the orifice was about 6 millimeters in diameter. The calisson bronchoscope was then inserted through the 9 millimeter bronchoscope while the latter exposed to view the orifice of the cavity. Into this orifice the calisson bronchoscope was readily inserted under guidance of the eye placed at its proximal end the distal end light furnishing brilliant illumination of the field. As soon as the distal end of the calisson bronchoscope entered the cavity the hand bulb was gently worked. The first effect was rather disappointing possibly because of excess of caution in pumping in the air with the bulb but gradually the flabby granulations were seen to separate and the secretions to disappear. The cavity walls if such they might be called, were seen to be of very irregular shape. Bands of tissue which seemed firm to the bronchoscope were seen to divide the cavity into numerous pockets, or fistulous tracts of small diameter. The continual collapse of the granulation tissue over the distal end of the calisson bronchoscope required the constant use of the hand bulb to keep up the positive pressure. This aroused some misgivings as to the possibility of

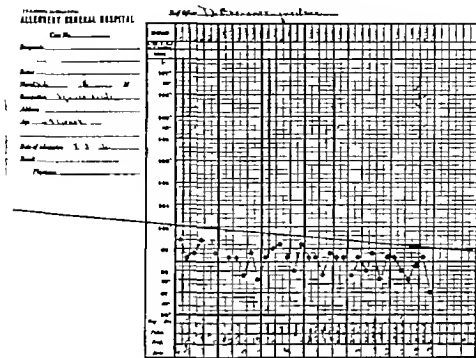


Fig 6 Chart of patient with lung abscess due to foreign body. Three bronchoscopies were done under local anesthesia during the six days shown on the chart without producing any reaction. The steady recession of the high point was probably due to better drainage following the bronchoscopic dilatation of the strictured orifice of the abscess cavity.

spreading infection by forcing pus into new regions. But the pressure was very gentle and moreover the quantity of pus the patient was coughing into the space between the 9 millimeter bronchoscope and the caisson bronchoscope justified the conclusion that the pus was escaping with the air around the caisson bronchoscope at the neck of the cavity where evidently there was not a very close fit. This seemed to render unnecessary any aircock for the release of pressure. My intention was instantly to withdraw the window plug if deemed necessary to release the pressure. Notwithstanding the fairly satisfactory exploration of the interior of the cavity no trace of the head of the pin could be found. It was then decided to make localizing roentgenograms with the forceps placed in position through the 9 millimeter bronchoscope.

**Third roentgenologic examination** (Second bronchoscopy though without search.) The 9 millimeter bronchoscope being introduced the forceps were introduced through it and two roentgenograms, one lateral the other anteroposterior were taken (Fig 5), by Dr George W. Grier. From these it was evident that the head of the pin was 4 centimeters below and 3 centimeters to the right of the orifice of the cavity. This position was around the corner so to say and could not be reached by a straight instrument especially because of the lessened elasticity or "displaceability" of the tissues in the neighborhood of the neck of the abscess cavity as compared to normal lung tissue.

**Third bronchoscopy** The malleable-ended forceps (Fig 2) were bent to what seemed the proper curve using the roentgenograms as a guide. Bronchoscopy was again done under local anesthesia and the bent malleable-ended forceps were inserted very carefully to the region of the foreign body as nearly as could be determined. As work was now being done without the guidance of the eye the forceps were very gently closed and no traction was made until the forceps were felt to close upon a hard substance that was felt to be free to move. Upon withdrawal the hard substance was found to be not glass but a black material the nature of which could not be determined. Further search resulted in removal of only small crumbs of black material.

**Fourth roentgenologic examination** Drs. Johnston and Grier made a remarkably clear series of plates and were unable to find anything resembling the head of the pin so plainly visible in all the plates of the second and third roentgenologic examinations and it was their opinion that no fragment of the pin large enough to be visible in a radiogram, remained in the patient's lung.

The patient's temperature on admission was 99.3. There was no reaction following any of the bronchoscopies. On the contrary the temperature chart showed a steady decrease in its high point throughout the six days during which the successive bronchos-



copies were done (Fig. 6) the recession of the high points being probably due to improved drainage following the dilatation and the bronchoscopic removal of pus.

It may be here mentioned that this is the fourteenth case of prolonged sojourn of a foreign body in the lung that has come to us. There has since been one case making 15 in all. Of the 15 cases the foreign body was removed in all but one. All but two of the cases entirely recovered their health. These two were in apparent progress of complete cure when they suddenly became ill one at the end of a month from embolism of the middle meningeal the other from a secondary pus focus low in the thorax & high in the abdomen. Casson bronchoscopy was not used in either of these cases.

#### CONCLUSIONS

1 While Casson bronchoscopy was unsuccessful in finding the foreign body in this case the usefulness of the method in the exploration of the interior of lung abscesses and the safety of such exploration when care-

fully done were demonstrated. That a larger foreign body or one not in an eccentrically located pocket could be so found seems probable.

2 The usefulness of the new malleable-ended forceps in conjunction with localizing roentgenogram made with ordinary straight forceps in position at endoscopically known stations.

3 Numerous other points though not entirely new are important especially

a Absence of reaction following careful bronchoscopy under local anesthesia in adults.

b Lessened absorption of pus owing to improved drainage following dilatation of the strictured orifice of the abscess cavity.

c The corrosion of steel in the lung without disintegration sufficient to permit coughing out probably because of the firm enclosure of fibrous tissue.

d The localizing value of the antero-posterior and lateral roentgenograms with the bronchoscope and forceps at various stations of which the endoscopic landmarks are known.

## CYSTIC HYGROMATA AND OTHER TUMORS OCCURRING IN INFANCY<sup>1</sup>

By RANDOLPH WINSLOW, M.D., B. T. MORGAN

I DESIRE to place on record the following cases of tumors of the neck and pectoral region in children which though not unique are rare and I hope of sufficient interest to justify their presentation.

CASE 1. Cystic hygroma of the neck. On March 1909 there was admitted to University Hospital 1, Baltimore, William B., 5 months old with a large soft swelling on the right side of the neck extending from the midline in front almost to the midline posteriorly and from the ramus of the jaw to the clavicle. This was painless, not tender, freely movable laterally but with little motion in an up and down direction. The skin was freely movable over the tumor and was of normal appearance. A sensation of emulsionization seemed to be present. The mass seemed to be external to the sternocleidomastoid muscle. There was no glandular enlargement. The child was an exceptionally healthy looking and well developed infant and

was apparently normal in every manner except that the weight was less than normal for a normal labor. My records do not state to what time the tumor was first noticed. I had never seen such a condition in an infant and was reluctant as to the diagnosis. In this case I met some years previously who had a large soft tumor extending from the base of the skull to the clavicle. I thought I had to deal with a bronchial cystoma but on operation soft lipoma was easily handled out. I was therefore inclined to think that the present swelling was soft lipoma and advised its removal.

On operation on March 3, 1900, I discovered that I had to deal with a multilocular cyst containing limpid fluid. The most extensive ramification of the cysts became very minute and extending under the skin and esophagus and between the muscles in every direction. Unfortunately the operation was prolonged and the child became shocked from which he did not recover.

The report of the pathologist was simply cystic hygroma.



Fig 1 Cystic hygroma of neck in child 5 months of age

During the same year another child with a somewhat similar appearing tumor was brought to me

**CASE 2** Soft lipoma of neck. S. G. aged 2 years had a large soft swelling in the midline of the root of the neck and overlying the sternum. It was soft semisfluctuant painless slowly growing and, as far as signs went might have been a cystic hygroma a thyroid or possibly thymus cyst. Bearing in mind the unfortunate termination of the preceding case I advised delay and sent the child home. I did not see him for 14 years when he returned to me in September 1915 to have the tumor removed. He was now a strapping fellow 16 years of age but the lump was of about the same proportionate size as it had been when he was first brought to me in 1901. It may perhaps have extended more over the sternum than it did at first. The diagnosis of lipoma was made and the mass was enucleated without any difficulty.

In this case the diagnostic uncertainties were reversed and instead of a hygroma we had a lipoma.

**CASE 3** Cystic hygroma of right pectoral region and shoulder. E. W. aged 3½ years entered University Hospital on November 4, 1908 and was discharged on November 25, 1908. He is a healthy plump and well developed boy with a good appetite regular bowels and undisturbed sleep.

About two years ago he was run into by another boy after which a lump formed on the right shoulder. The growth is situated on and anterior to the right shoulder and has been growing insidiously for two years. It is about the size of a newborn baby's head and is tense and cystic. On the interior of the lump numerous small bodies like phlebotomies



Fig 2 Cystic hygroma shoulder

can be felt and numerous veins can be seen coursing over its surface. It is painless movable and uninflamed. There is no glandular enlargement.

I am frank to confess that I did not recognize the condition but thought I was dealing with a cavernous angioma and undertook its removal with much trepidation.

Operation November 16, 1908. A curved incision was made over the tumor with its convexity downward and then it was seen that it consisted of myriads of vesicles filled with clear fluid. I was fortunate enough to be able to remove the mass without difficulty and the patient made a good recovery.

In addition to the above cases I had the opportunity of seeing the following case occurring in the service of my colleague Dr. J. Holmes Smith, at the University Hospital.

**CASE 4** Cystic hygroma of the neck. C. O. colored aged 19 was admitted on March 18, 1912 and discharged cured on March 28, 1912.

The patient is a healthy young colored man who works in a glass factory. He came to the hospital on account of a large soft swelling on the left side of the neck which is about the size of a closed fist. His family and personal history are unimportant. About one year ago he first noticed a small swelling on the neck toward the back which gradually increased and extended forward. There was no pain or tenderness or glandular involvement but about this time there seemed to be evidence of pressure which distressed him.

Operation on March 21, 1912 by Professor Smith. An incision disclosed a large multilocular cystic tumor containing clear serous fluid. This mass was extirpated without much difficulty and the patient made a good recovery.

The pathologist's diagnosis was hygroma. The microscopical examination showing the cyst wall lined with an endothelial layer.

Notwithstanding the occurrence of these cases in my own practice my interest in the subject was not especially aroused until I read the article by Charles N. Dowd in the *Annals of Surgery* July 1913.

The condition is rare and according to Dowd only 91 cases of cystic hygroma of the neck had been reported in the literature previous to his article. 35 cases of cystic hygroma of the axilla and 11 cases in other portions of the body. Dowd reports 4 cases in his own practice occurring during one year. Since his article appeared other cases have been reported by Matthew Downes and Lyle in the *Annals of Surgery* vol. 59 and 60.

The disease occurs in infancy in the vast majority of cases but may also occasionally be found in adults.

The diagnosis seems to me to be somewhat difficult though with renewed attention called to the subject hygroma should at least come into consideration in doubtful tumors of the neck and pectoral region occurring in infancy.

The symptoms in the cases observed by me were the occurrence of a painless slowly growing tumor soft and semifluctuating in consistence with here and there harder lumps embedded in the mass the skin freely movable over the tumor but the growth not freely movable on the underlying tissues. The large size of the tumors and the early age at which they occur are strongly suggestive of this condition. Males and females are affected in about equal proportion with

a slight preponderance of males. Right and left sides may be affected but apparently it occurs more frequently on the right side.

I had supposed that these large cystic tumors were the result of an obstruction of the main lymph-channel but in such a case there ought to be an extensive lymph edema of the area drained by these lymphatics which is not the case.

Dr. Dowd believes the condition is due to embryonic sequestration of lymphatic tissue and says the cysts have the endothelial lining of the lymph vessels which can and should be demonstrated by staining them with nitrate of silver.

*Treatment.* The treatment of cystic hygroma is a matter for very serious consideration. According to the statistical tables of Dowd 90 cases of hygroma of the neck were subjected to operative procedures of some kind including punctures injections and excisions with 39 deaths or 43 per cent mortality while of 35 cases of hygroma of the axilla 5 died or 14 per cent. Moreover in many cases it will be impossible to remove the growth completely and incomplete removals are followed by recurrence and according to John B. Murphy are liable to become carcinomatous. Punctures and injections seem to be attended with about as great mortality as excision and are less certain in their results.

It would seem to be good policy not to operate on these cases in children unless pressure or other symptoms urgently demand intervention. When operation is indicated excision should be done.

LIGATION OR EXCISION OF THE PELVIC VEINS IN THE TREATMENT OF PUERPERAL PYÆMIA<sup>1</sup>

By C. JEFF MILLER, M.D., F.A.C.S., NEW ORLEANS

In recent years there has been a gradual trend toward conservative rather than active surgical measures in the treatment of puerperal infection. This gradual growth of conservatism is due to various factors among which might be mentioned more thorough knowledge of the varying virulency of the invading bacteria and the positive harm that results from disturbing local conditions in the presence of certain bacteria. It was also natural to revert to expectant methods after it was shown that the results obtained by such radical measures as hysterectomy, early laparotomy with drainage, repeated curettage and similar suggestions had been followed with such disastrous results.

The many gradations of puerperal infection, the varying virulency of bacteria and the fact that we have no reliable clinical or laboratory guides to aid in determining a reasonable prognosis make the formulation of indications for surgical intervention a difficult problem. For these various reasons active surgical measures have given way to expectant treatment and the results have fully justified the change.

This has not been true however of puerperal pyæmia. No method of treatment appears to have reduced to any great degree the high mortality of this type of infection. It still remains the most serious complication that may arise during the puerperium.

The frequency and seriousness of it can be readily understood. The most favorable conditions for bacterial invasion of the blood channels are presented by the gaping veins at the placental site, the constant presence of bacteria in the vagina and cervix and the traumatism incident to labor.

If the invading bacteria are of a virulent type a severe bacteræmia, or peritonitis results before local processes may bar their advance and death occurs with little if any local evidence of disease. Such cases are

doomed from the beginning and rarely respond to any method of treatment.

In another type, the greater resistance of the patient, or lesser virulence of the bacteria allows time for protective thrombi to form which may check the advance of infection to the general system. This protection usually consists of phlebitis and thrombosis in one or more of the pelvic veins. Here the infection may be limited or the thrombi may gradually extend and cause death by involving major venous trunks. More frequently the thrombus undergoes liquefaction and liberates emboli which convey infection to remote areas and establish metastatic foci or abscesses. This last type is characterized as pyæmia and it was with the idea of determining whether surgery could close the venous channels and prevent dissemination of crumbling thrombi that this collection of case reports was made.

The idea is by no means new for John Hunter in 1784 proposed such a procedure and successfully treated a case of pyæmia by ligating the saphenous vein. During the latter half of the last century many cases were recorded of the successful control of pyæmia by ligating or excising various veins but the procedure did not receive general approval. About twenty years ago hysterectomy for serious puerperal lesions was given a thorough trial and ultimately abandoned except for unusual conditions.

It was then that Sippel in 1894 and Freund in 1898 proposed excising the spermatic veins in addition to hysterectomy but as has already been mentioned hysterectomy had been so disastrous that their suggestions passed practically unnoticed.

The real impetus that prompted obstetricians to apply the principle of closing off pelvic veins containing crumbling thrombi was furnished by Zaefu's results in the treatment of pyæmia of otitic origin by ligation of the jugular vein.

Seven years after Zaulut's first contribution Viereck in 1901 published a series of 108 cases of which number 89 recovered. The operation promptly received unqualified endorsement.

One year later Trendelenburg and Bumm published their results of the method in puerperal pyæmia the former attacking the involved vein extraperitoneally the latter by the transperitoneal route.

Obstetricians have not been a fortunate class. He was able to show within seven years the value of the procedure in otitic pyæmia. It is now fourteen years since Trendelenburg's first contribution but sufficient material is not yet available to prove the practical value of ligation in the puerperal form.

Trendelenburg reasons for adopting the operation are so concisely stated and are based upon such excellent deductions that his statement is worthy of repetition.

It seems quite natural to ask why this same plan of procedure can not be followed in the treatment of puerperal pyæmia if such excellent results are obtained in analogous condition. There are no marked differences in the pathologic sense between these two forms of pyæmia. In both we meet with instances of pure thrombophlebitis and in some cases the lymphatic vessel are involved in the infectious process. The clot formation extends in the same manner in both types metastatic deposits are liable to occur in both and the bacteriologic findings are likewise identical in both examination of the circulating blood often may prove negative even in severe cases. In both forms we may find diffuse inflammation or a localized abscess in the neighborhood of the thrombus in the otitic variety meningitis or cerebral abscess in the puerperal peritonitis or abscess of the ovary or parametrium. Finally in either a spontaneous recovery may result the thrombus becoming organized.

It must be admitted that Trendelenburg's conclusions are at least convincing as to the feasibility of the operation as a surgical proposition.

There are four phases of the subject to be considered in any effort to draw conclusions

a. to the practical value of controlling septic invasion by ligating or excising infected pelvic veins.

1. Can septic thrombophlebitis be recognized with sufficient accuracy to justify a serious operation?

2. Do the pathologic conditions revealed at operation and autopsy justify intervention?

3. The indications for operation.

4. Has the mortality been reduced by operation?

#### DIAGNOSIS

A cursory review of the numerous contributions on this subject promptly reveals the fact that the difficulties of diagnosis constitute one of the leading objections to the operation. Correspondence with many leading American obstetricians showed that they were especially skeptical on this point. It was interesting to compare their conservative statements with those of many German clinicians. Seitz insists that a diagnosis is possible in the majority of cases. Bumm, Opatz, Bardeleben, Leopold and Trendelenburg practically agree with Seitz but differ as to how early a positive diagnosis can be made.

The most important diagnostic feature is unquestionably the occurrence of chills and since we must rely chiefly upon their repetition it is unfortunate that they so often exhibit such a wide variability in type, time of occurrence and even absence in some cases.

Williams, Bardeleben and Lejars state that the occurrence of chills and hectic temperature renders the diagnosis assured whenever thrombosed vessel can be palpated as irregular worm like masses high up in the outer portion of the broad ligament or along the spermatic veins.

Lenhartz found it possible to palpate thrombosed vessels in 80 per cent of his cases.

It is unnecessary to enumerate the possible conditions that may confuse the clinician in the early stages of thrombosis. The difficulties are obvious and few will agree with Saxes who states that the characteristic symptomatology is best seen in the acute stage. In the acute form the general toxic symptoms predominate and confuse the

picture to even the most experienced diagnostician.

Thrombosed pelvic veins present definite and fairly characteristic physical signs but are likely to be confused with pyosalpinx and parametritis both of which present, as a rule, a more persistent temperature with less tendency to recurrent rigors and considerable pain.

The absence of pain in thrombosis is mentioned by the majority of clinicians. Pain may be present in the beginning of thrombosis but is absent in most cases of pure thrombosis (Jellett). The broad ligament is not fixed as in cellulitis nor does the mass approach the pelvic wall as in simple exudates.

Unfortunately examination of the blood has proved of little value except as a factor in prognosis. Even Lenhartz who found the blood cultures negative in only 3 of 16 cases speaks disparagingly of blood studies and Palm and Warnekros insist that the varying results of blood studies are attributable to differences in technique but, concede that the laboratory findings are of secondary importance.

The frequency of the affection should possess some diagnostic value. A condition found in one third to one half of all women dying of puerperal infection should emphasize the probability of its presence in a given case.

Summarizing the above-mentioned features it would seem that septic thrombophlebitis has a fairly characteristic symptomatology and in a given case presenting high temperature with pronounced remissions the absence of pelvic exudates and peritonitis with the uterus empty and correspondingly involuted a diagnosis should not be difficult.

Do the pathologic findings revealed at operation or autopsy justify surgical intervention?

The first attempt to arrest puerperal pyæmia by venous ligation was based upon autopsy findings that showed a practically normal genital tract with the exception of thrombosed ovarian veins. Seeger found 26 cases out of 31 autopsies to be of the pure thrombophlebitic type. Only 5 showed a mixed or marked lymphatic involvement.

An argument used against disturbing thrombosed veins is that the thrombus is a conservative process. Another is that septic endometritis is practically always present and that ligating or excising individual veins will not close all the possible avenues to the general blood stream.

The answer to these objections is that a thrombus may be conservative but ceases to be so when liquefaction occurs and septic emboli begin to invade the blood and furthermore the patient can usually withstand a septic endometritis if the veins do not become thrombosed and discharge infected emboli.

The basic principle underlying ligation of infected veins is dependent upon the behavior of streptococci when introduced into the veins.

Bardeleben has proved that the vessel wall provides powerful resistance to the streptococcus. It is somewhat of an obstacle even to the highly virulent and almost an unsurmountable wall to the benign streptococci. This degree of resistance is possessed by no other tissue and since it has been shown that a single vein is involved in the majority of instances it would seem to be further proof that surgical intervention is a rational procedure.

It was difficult to ascertain the relative frequency of the veins involved. The first estimates were based upon autopsy reports which represented terminal infections and not the conditions which would have been found if an operation had been performed days or weeks before death.

Seeger found it confined to one or both spermatics. Trendelenburg found bilateral as often as unilateral thrombosis and the hypogastrics thrombosed twice as often as the spermatics. Recklinghausen Seitz and Venus found a single spermatic more frequently involved.

The appended tables show the exact location of the thrombus in 100 of the 197 cases at the time of operation.

Vein involved	Number of times
1 spermatic	75
2 spermatic	5
1 hypogastric	6
1 hypogastric and 1 spermatic	6
1 common iliac	8

This proves conclusively the tendency of the thrombosis to limit itself to one vein usually the spermatic, and that a marked difference exists as to the frequency and location of thrombi when viewed at operation and at autopsy

Operation	Total	Recoveries	Deaths
During first week	3	9	4
During second week	7		5
During third week	20		0
During fourth week	20	8	1
During fifth week		8	3
During sixth week	7	3	4
During seventh week	5		3

#### INDICATIONS FOR OPERATION

If we can be certain of a diagnosis in a given disease we are usually sure of the pathology and fairly certain of the prognosis. We also know what we can do or at least what we are justified in attempting to do. Since we cannot be certain of the diagnosis of septic thrombophlebitis or the virulence of the bacteria, the indications for operation are necessarily open to discussion.

Many advise operation at the earliest time after a diagnosis is made yet, To operate too soon would be a crime too late useless says Tuffier. How can it be proved that a given case would not have recovered without operation? This is a question not easily answered but it must be considered something more than mere coincidence when the active symptoms subside promptly after operation in more than 25 per cent of the cases.

Trendelenburg proposed operation after the first chill Bondy Schottmuller and Beuttner after three chills and the demonstration of anaerobic streptococci in the blood cultures and Bucarus after five chills. Seitz rather urges late operation. Lenthartz would interfere only when unilateral thrombosis can be determined. Williams and Bardeleben give the same indications viz. operate as soon after chills or high fever that thrombosed veins can be detected by palpation.

All observers, except Venus believe that chronic pyæmia yields the highest percentage of recoveries after operation. Venus favors early operation basing his opinion on the fact that 53.8 per cent operated upon during the first two weeks recovered, and only 42.8 per cent recovered who were subjected to operation between the third and fourth week.

Of the 197 cases collected in the appended tables the time of operation was stated in 103 cases.

The other cases were operated upon from 8 to 11 weeks after the onset but the number was too small to be of statistical value.

These figures seem to confirm Venus' contention that early operation yields a larger percentage of recoveries.

Since Bunim is so emphatic in warning against interference in acute pyæmia, the question might well be asked as to the means of differentiating between the acute and chronic forms. There is undoubtedly a difference but a definite line can not be drawn.

The acute stage during which the general toxic symptoms predominate lasts usually 8 to 10 days after which definite localization in the veins takes place and the constancy of symptoms becomes more decided.

A case would ordinarily be considered as having entered the chronic stage after a duration of 10 to 15 days.

A glance at the case histories will show the futility of operating in cases presenting evidence of peritonitis broad ligament abscess and multiple metastatic abscesses.

Acute endocarditis, pulmonary abscess or a definite pneumonia, usually indicates a general pyæmia and are to be considered contra indications to operation.

Williams believes that a localized pleurisy due to isolated pulmonary infarction or even signs of beginning pneumonia, do not necessarily contra indicate intervention.

The case reports show however that almost all of the cases showing signs of peritonitis died and that few recovered that presented pulmonary lesions.

Some have opposed operation on the ground that pyæmic subjects are poor surgical risks. The statistics show that less than 3 per cent died as a direct result of operation.

One of the chief reasons for early operation is to prevent the extension of the thrombus to the vena cava. Twenty two cases in the appended series revealed at autopsy an extension of the thrombus to the vena cava.

In most of these the thrombus continued from the site of ligation of the involved vein

#### TECHNIQUE

It is not necessary to dwell upon the details of operative technique further than to state that the original plan of Trendelenburg of attaching the veins extrapentoneally has been practically abandoned. I found no cases to add to the fifteen collected by Williams in 1909 that had been treated in this manner.

The vaginal route proposed by Taylor and Latzko never found favor except with the originators.

In view of the location of the thrombus and the incidental complications the transperitoneal operation is the only method worthy of consideration.

Whether the thrombosed vein is to be simply ligated or excised depends upon circumstances.

In pure septic thrombosis ligation of the involved vein is considered sufficient. The ideal operation would demand the removal of the infected focus or else the closing off of every outlet of bacteria but neither is possible.

Excision should be reserved for periphebitic processes or when the thrombosed vein presents areas of softening which appear likely to lead to perforation.

Whether ligation or excision is to be attempted depends also upon the vein involved. Excision of an ovarian vein would be very little more difficult than ligation but the deep pelvic veins would present almost insurmountable difficulties.

Warnekros urges ligation of the common iliac on the affected side as a routine measure in thrombosis of the deep veins and like Trendelenburg believes that in extensive thrombosis the vena cava may be tied without fear of subsequent gangrene. Bumm first proposed ligation of all four of the veins and Bardeleben approved it but the case reports show that the suggestion has not met with general approval. A suggestion made by Vent seems rational viz. that the number of vessels to be tied depends upon the duration of the disease. The earlier the operation the greater the number to be ligated.

It is well to warn against digging into the venous plexus at the sides of the uterus and in the parametrium since aside from the slight probability of encompassing the entire field of the thrombosis the possibility of severe hemorrhage is shown in several case histories.

Ligation of the hypogastric has not been satisfactory as the records will show. Bumm has substituted ligation of the common iliac of the affected side as offering greater chances of working in a germ free area and being technically simpler.

Ligation of the common iliac as a routine practice when the deeper vessels are involved should have a thorough trial. The accompanying case reports at least show that the mortality is no greater than ligation of a single hypogastric.

#### HAS THE MORTALITY BEEN REDUCED BY OPERATION

In order to determine the value of surgical intervention it is necessary to know what results have been obtained by expectant treatment.

It is fairly definitely settled that the average mortality of puerperal pyæmia is between 60 and 70 per cent. Sippel placed it at 100 per cent, von Winkel at 95 per cent, Curschmann at 66 per cent, and Graefe at 82 per cent. Jellett states that in those cases in which suppuration occurs in the vein, the death rate is 100 per cent. In Williams service 66⅓ per cent died.

These several estimates only emphasize the fact that it is the most serious malady that may attack the lying-in woman and would justify any reasonable procedure calculated to reduce such a frightful mortality.

In order to compare the results I have arranged in the accompanying histories every case record to be found in the literature from the date of Freund's first article in 1894 up to July 1, 1916. The material has been arranged according to the form adopted by J. Whitridge Williams in his excellent review of the subject in 1909. I have simply continued his series up to date.

Some critics who insist that we have no way to judge statistics except as they appear



in cold figures will take exception to the attempt made to correct the mortality as has been done. A detailed study of the histories will justify the elimination of numerous cases that were absolutely hopeless at the time of operation. In fact, some were very little more than autopsies.

Cases of extensive cava thrombosis, acute peritonitis, faulty ligation of vessels, broad ligament abscess, and multiple metastatic processes should not be included in the series, since they are distinctly stated to be contra-indication to operation.

The peritoneal recoveries after peritonitis has not been encouraging as we had hoped to find it, but taken as a whole the results were not altogether discouraging. Seitz found that 38 per cent of the cases in his collection recovered and such an experienced observer as Lenhartz, who reviewed Seitz's case reports, stated that perhaps all of them would have died without operation.

Banes showed a gross mortality of 33.4 per cent without any deduction.

Williams found the gross mortality of transperitoneal operations to be 43.9 with the corrected mortality of 21.4 per cent.

Venus in 115 cases showed the mortality in acute pyæmia to be 35 per cent in the chronic form 39.2.

One hundred and ninety seven cases are included in this series. Fifteen were treated by the extraperitoneal and 182 by the transperitoneal operation. The gross mortality (not including the vena cava series) was 51.6 per cent. The corrected mortality was found to be 33.9 per cent. The cases eliminated in estimating the corrected mortality are so designated in order that any investigator may draw his own conclusions as to the correctness of the statistics.

#### SERIES A — EXTRAPERITONEAL OPERATIONS

**CASE.** Reported by Trendelenburg 1902. Patient aged 35 had chills daily and high temperature following abortion. Patient's general condition poor. Operation disclosed thrombosis of the right spermatic and hypogastric. Twentieth day broad ligament abscess opened. Fifth third day ligated right hypogastric second third day ligated right spermatic. Recovery.

**CASES 2 to 5.** Reported by Trendelenburg 90. Acute cases. No details given. All died.

**CASE 6.** Reported by Michels 1903. Patient aged 29 (abortion) had first chill on fourth day. Chills daily, highest temperature 40.8° C. General condition of patient serious. Operation twenty third day (the onset of symptoms). Thrombosis of left spermatic excised. Patient died.

**CASE 7.** Reported by Lenhartz 1906. Patient aged 31 (abortion) had first chill second day followed by many chills. Highest temperature 41° C. Patient in poor condition. Operated on twenty sixth day after onset of symptoms. Thrombosis of left spermatic excised. Autopsy revealed peritonitis and left ureter tied off.

**CASE 8.** Reported by Lenhartz 1906. Patient aged 31 (abortion). First chill fifth day followed by many chills. High temperature. General condition of patient bad. Operation 55 days after abortion. Thrombosis of right hypogastric. 60 days later excision of right spermatic. Recovery.

**CASE 9.** Reported by Lenhartz 1906. Patient aged 41 (full term) had first chill ninth day followed by 4 chills. High temperature. General condition of patient bad. Operation 4 days after onset of symptoms. Vessels of right side embedded in inflammatory tissue both ligated. Patient died. Autopsy revealed a thrombosis. Pudic vein ligated for hypogastric.

**CASE 10.** Reported by Lenhartz 1906. Patient aged 40 (abortion) had first chill third day followed by many chills. High temperature. General condition of patient bad. Operation 64 days after abortion. Thrombosis of left spermatic and in terminal iliac which were ligated. Patient died. Autopsy revealed lung abscesses, a thrombosis, two thromboses of left femoral vein.

**CASE 11.** Reported by Lenhartz 1906. Patient aged 20 (full term) had first chill eleventh day after onset of symptoms, followed by several chills. Highest temperature 41.4° C. General condition of patient bad. Operation 1 day after delivery. Thrombosis of left common iliac, spermatic and saphenous all three of which were ligated. Patient died. Autopsy revealed peritonitis but thrombosis in spermatic above ligature.

**CASE 12.** Reported by Lenhartz 1906. Patient aged 41 (abortion) had first chill second day after onset of symptoms, followed by many chills. Temperature unknown. General condition of patient bad. Operated on twenty-eighth day disclosed thrombosis of left common iliac and spermatic. Both ligated. Patient died. Autopsy revealed cava thrombosis, infarct right lung and liver abscess.

**CASE 13.** Reported by Lenhartz 1906. Patient aged 29 (full term). Date of first chill, number of chills and temperature unknown. General condition of patient bad. Operation eighth day disclosed thrombosis of right hypogastric and spermatic. Both ligated. Patient died. Autopsy revealed pudic ligated for hypogastric. Small vein for spermatic. Original vessels thrombosed.

CASE 14. Reported by Lenhartz 1906. Patient aged 43 (abortion) had first chill sixth day followed by 12. Temperature unknown. General condition of patient bad. Operation twelfth day disclosed thrombosis of left spermatic and hypogastric. Both ligated. Patient died. Autopsy revealed lung abscess no thrombosis above ligation.

CASE 15. Reported by Bland Sutton 1909. Patient aged 35 (abortion) had first chill twelfth day. Number of chills and temperature unknown. General condition of patient poor. Time of operation unknown. Thrombosis peritonitis. Prognosis no hope of recovery. Excision right hypogastric ligation to spermatic and iliac vein. Laparotomy and drainage. Patient died eighth day. Autopsy revealed thrombosis of right common and internal iliac pulmonary embolism.

#### SUMMARY

Fifteen cases 12 deaths 80 per cent mortality. Spermatic vein excised 2 cases 1 death from peritonitis. Spermatic and hypogastric veins ligated 8 cases 6 deaths. Acute pyæmia 4 cases all fatal. Deducting 2 cases for cava thrombosis, 2 for ligation of wrong vessels and 5 for acute pyæmia one finds that 3 favorable cases were operated upon with 3 recoveries. Forty per cent corrected mortality.

NOTE.—These are the extraperitoneal cases originally tabulated by Williams. No cases have been reported since his article was published in 1909 hence it is reproduced without additions.

#### SERIES B—TRANSFIBROUS OPERATIONS ONE SPERMATIC VEIN EXCISED AFTER LAPAROTOMY

CASE 1. Reported by Freund 1898. Details not given. At time of operation, spermatic and cava thrombosed. Spermatic was excised. Patient died. Autopsy revealed metastases.

CASE 2. Reported by Freund 1898. Details not given at time of operation, all veins involved. Spermatic was excised. Patient died. No autopsy.

CASE 3. Reported by Bumm 1902. Details not given. Operation disclosed thrombosed spermatic and retroperitoneal phlegmon. Spermatic was excised. Result not stated.

CASE 4. Reported by Bumm 1902. Details not given. Laparotomy indicated thrombosis of left spermatic. Spermatic excised. Patient died. Autopsy revealed thrombosis above excision.

CASE 5. Reported by Bumm 1902. Details not given. Laparotomy indicated thrombosed spermatic and broad ligament involved. Complete excision was not possible. Result not stated.

CASE 6. Reported by Moore 1907. Patient aged 26 (abortion) had chill on third day followed by chills daily. Highest temperature was 106 with general condition bad. Operation 24 days after onset. Laparotomy indicated thrombosis right spermatic and broad ligament abscess. Right spermatic was excised. Clot above ligation right tube and ovary removed. Second operation 4 days later cava thrombosis. Patient died.

CASE 7. Reported by Moore, 190. Patient aged 29 (abortion), had first chill fifth day followed by daily chills. Highest temperature 107 with general condition bad. Operation 22 days after onset of symptoms. Laparotomy indicated thrombosis right spermatic. Right spermatic was excised and right tube and ovary removed. Recovery.

CASE 8. Reported by Leopold 1908. Patient aged 28 had first chill on thirtieth day followed by many chills. Highest temperature 40.4 C with general condition bad. Operation 40 days after delivery. Laparotomy revealed double femoral phlebitis and thrombosis of right spermatic. Right spermatic excised and right tube and ovary removed. Recovery.

CASE 9. Reported by Williams 1909. Patient aged 19 was 7 months pregnant. Had first chill third day followed by another chill. Highest temperature was 102 with general condition fair. Laparotomy fifth day indicated thrombosis right spermatic broad ligament indurated. Right spermatic excised right tube and ovary removed. Recovery.

CASE 10. Reported by Williams, 1909. Patient aged 25 (abortion) had first chill sixth day followed by chills daily. Highest temperature was 106 general condition poor. Operation 20 days after onset. Laparotomy indicated thrombosis right spermatic, with salpingitis and broad ligament abscess. Right spermatic excised right tube removed and abscess drained. Patient died.

CASE 11. Reported by Leopold, 1906. Patient aged 22 had first chill third day. Highest temperature was 40.9 C with general condition bad. Operation sixteenth day. Thrombosed spermatic vein was ligated and excised. Patient died. Autopsy revealed puerperal thrombophlebitis sepsis circumscribed peritonitis pleuritis.

CASE 12. Reported by Fabricius, 190. Patient aged 32 (abortion) had chills daily. Operation forty ninth day. Laparotomy indicated thrombosis right spermatic entire length parametrium free. Patient died. Autopsy revealed thrombophlebitis of right pelvic veins right iliac vein and femoral to middle of thigh. Vena cava to junction of hepatic vein.

CASE 13. Reported by Prochownik 190. Patient aged 33 (full term) had chills daily. Highest temperature 40.2 C. Operation ninth day after delivery. At operation, broad ligament contained thrombotic cords of veins. Right spermatic ligated and excised. Right spermatic artery ligated. Right broad ligament with small portion of uterus resected. Recovery.

CASE 14. Reported by Grad 190. Patient aged 23 (full term) had many chills. Highest temperature was 101. Operation 75 days after delivery. Laparotomy disclosed extensive pelvic adhesions pyosalpinx, thromboses of ovarian artery. (Grad states this is the only case of thrombosis of ovarian artery mentioned in *Index Medicus*.) Recovery.

CASE 15 Reported by Steffen, 1908 Details not given Laparotomy fortieth day disclosed thrombosed spermatic vein Veins showed crumbling disintegration. Spermatic vein excised Recovery

CASE 16 Reported by Koblanck 1909 Patient aged 23 (full term) had first chill second day followed by chills daily General condition bad Operation 4 days after onset At operation, left spermatic vein thrombosed to size of thumb and contained reddish pus Left spermatic a part of uterine wall and left adnexa resected (2 chills after operation.) Recovery

CASE 17 Reported by Koblanck 1909 Patient at term age unknown First chill twenty-first day Highest temperature 41 C General condition bad At operation on tumor and intestine adherent and watery pus in coils of bowel ovarian abscess thrombosed ovarian vein Spermatic vein resected after ligation Chills continued with death on eighth day Autopsy revealed acute myocarditis right lung abscess suppurative peritonitis suppurative parametritis Spermatic thrombosis continued up into vena cava with purulent disintegration

CASE 18. Reported by Koblanck, 1909 Patient aged 36 (abortion) had first chill sixth day followed by chills daily Operation fifteenth day Highest temperature 4 C At operation right spermatic thrombosed paraphimosis abscess (streptococci) Right spermatic and thrombosed cornua of uterus excised Death on seventh day Autopsy revealed pulmonary abscess abscess behind vena cava hypogastric vein filled with suppurative thrombi

CASE 19. Reported by Koblanck 1909. Patient aged 38 (abortion) Highest temperature 39 C Operation fifth day after onset of symptoms. At operation, left spermatic vein thrombosed abscess of left ovary left spermatic vein size of finger and contained pus (streptococci) Left spermatic vein was resected and left adnexa extirpated. Temperature normal on third day Recovery

CASE 20 Reported by Vineberg 1900. Patient aged 36 (full term) had first chill twenty-sixth day followed by frequent chills. Highest temperature 105.4 General condition of patient good. Operation 3 days after delivery Blood cultures showed streptococci. At operation right spermatic thrombosed to size of thumb extending to vena cava. Right spermatic vein excised. Death on nineteenth day Autopsy revealed vena cava thrombosed at entrance of right ovarian vein. Retrograde thrombophlebitis down to common iliac Uterus normal

CASE 21 Reported by Michels 1909 Patient aged 38 (abortion) had first chill third day followed by chills daily Highest temperature was 104.6 with general condition bad Operation eleventh day after onset of symptoms. At operation, right broad ligament distended with coils of thrombosed veins. Right ovary thrombosed.

Right ovarian vein was ligated then excised, together with right broad ligament, owing to friable tissues. Ultimately uterus was amputated to control bleeding No chills after fourth day Recovery

CASE 22 Reported by Asch, 1909 History unknown One spermatic ligated and excised. Patient died Autopsy showed other spermatic involved no peritonitis.

CASE 23 Reported by Thorn 1912 History unknown Operation disclosed thrombus of right spermatic vein. Right spermatic vein ligated and excised. Patient died. Autopsy revealed thrombus extending above ligation lung abscess.

CASE 24. Reported by Magnus, 1913 Patient aged 22 had first chill sixth day followed by chills daily Temperature 39.2 C General condition of patient serious Operation 20 days after delivery At operation ovary size of hen's egg right spermatic vein thrombosed Right spermatic vein was ligated ligature cut through Ends were excised and cauterized. Much improved 10 days after then grew worse Died twenty-sixth day Autopsy showed pulmonary embolism and uremia.

CASE 25 Reported by Huggins, 1912 Patient aged 28 (full term) had first chill first day followed by chills daily Highest temperature was 105, with general condition bad Operation disclosed broad ligament oedematous and right tube adherent thrombosed right spermatic vein extending nearly to aortic peritoneal pus collection (smears from broad ligament showed streptococci) Right spermatic vein was ligated about 3 centimeters from terminus then removed down to broad ligament Patient died eighth day Chronic nephritis suspected

CASE 26 Reported by Huggins 1912 Patient aged 28 (full term), had first chill sixth day followed by frequent chills. Highest temperature 104 with general condition serious. Operation twenty-second day of disease Operation disclosed mass beginning at outer end of broad ligament thrombosed right spermatic vein periphlebitis (smears from vein showed streptococci) Right spermatic vein ligated and excised Recovery

CASE 27 Reported by Veit, 1913 Patient aged 31 (abortion) had first chill seventh day followed by frequent chills. Temperature was high general condition bad Operation 9 days after onset disclosed right spermatic vein thrombosed and surrounded by pus. Vein was ligated and excised above thrombus Greasy material in vein. Patient died. Autopsy showed peritonitis. Recovery apparently impossible from beginning

CASE 28. Reported by Lewis 1913 General condition of patient bad Highest temperature was 105 Operation 5 days after onset disclosed right spermatic vein thrombosed. Right ovarian vein with tube and ovary ligated and excised. Recovery

CASE 29 Reported by Jellitt 1913 Patient aged 26 (full term) had first chill eighteenth day

followed by chills daily. Highest temperature was 104.5. Operation 39 days after delivery disclosed thrombosis of right ovarian vein. Right ovarian artery showed thick wall lumen closed. Ovarian artery and vein were excised as far as possible and broad ligament extirpated. Recovery.

CASE 30. Reported by Jellett 1913. Patient aged 30 (full term) had first chill eighth day followed by frequent chills. Highest temperature 102. Operation 15 days after symptoms developed disclosed hard swelling in right broad ligament extending along ovarian vessels almost to vena cava. Mass in broad ligament enucleated. Ovarian vein ligated and excised. Ovarian artery ligated. Recovery.

CASE 31. Reported by Jellett 1913. Patient aged 23 (full term) had first chill seventh day followed by frequent chills. Highest temperature was 105. Operation eighteenth day of disease disclosed incipient peritonitis. Right broad ligament thickened, continuing along ovarian vessels. Periphlebitic abscess along ovarian vein. Vein very friable. Right ovarian vein and right broad ligament removed. Pus flowed freely from broken ends of veins. At second operation pus was found around right uterine vessels. Vessels were cut and it was thought pus came out of some of the veins. Patient died.

CASE 32. Reported by Eden, 1913. Patient aged 21. Details not given. Operation thirty fifth day disclosed thrombosis of left ovarian vein. Ovarian vein and artery were dissected out from renal vein to uterus. Left tube and ovary removed. Rapid recovery.

CASE 33. Reported by Sigwart, 1913. Patient aged 22 had first chill sixteenth day, followed by chills daily. General condition fair. Operation disclosed right spermatic vein thrombosed. Spermatic vein was ligated near cava. No more chills. Recovery.

CASE 34. Reported by Asch 1913. Highest temperature was 40 C. Details not given. Operation 4 days after onset of symptoms disclosed adhesions of left tube and ovary. Left spermatic thrombosed to region of kidney. Paraphlebitis exudates. Left parametrium oedematous. Left spermatic vein was ligated and excised, and left adnexa removed with small wedge-shaped portion of uterus. Streptococæmia. Recovery.

CASE 35. Reported by Brown 1914. Patient aged 29 (full term). Details not given. General condition serious. Operation 15 days after onset of symptoms disclosed left ovary oedematous and thrombosis of left spermatic vein. Spermatic vein was ligated almost entire length and excised. Left tube and ovary removed. Streptococæmia. Patient died.

#### SUMMARY

Total 35 cases. Results not stated in 2 cases. Of 33 cases 17 died, 16 recovered. Gross mortality 51.5 per cent. Deduct cases 1 and 6 of cava thrombosis 2 in which all veins were involved, 3 5 10 18

25 of broad ligament abscess 4 and 20 in which the thrombosis extended above the point of excision, 27 of periphlebitic abscess and 18 and 31 in which peritonitis already existed at the time of operation and there remain 20 favorable cases with 16 recoveries. Corrected mortality 20 per cent.

#### SERIES C—TRANSPIRITONEAL OPERATIONS. LIGATION OF ONE SPERMATIC VEIN AFTER LAPAROTOMY

CASE 36. Reported by Cuff 1906. Patient aged 30 (term) had first chill second day followed by many chills. Highest temperature was 105 with general condition poor. Operation 27 days after onset of symptoms disclosed thrombosis of right spermatic and indurated broad ligament. Right spermatic was ligated. Recovery.

CASE 37. Reported by Lendon, 1907. Patient aged 24 (term) had first chill second day followed by frequent chills. General condition bad. Operation seventh day of symptoms disclosed thrombosis of right spermatic. Right spermatic ligated. Recovery.

CASE 38. Reported by Seitz 1907. Patient aged 23 (term) had first chill fourth day followed by many chills. Highest temperature 41 C. General condition poor. Operation fourteenth day of disease disclosed acute pyæmia. Right ovary size of an egg. Right spermatic ligated. Ovary not removed. Recovery.

CASE 39. Reported by Berkofsky 1908. Patient aged 30 (term) had first chill third day followed by chills daily. General condition fair. Operation eighth day of symptoms disclosed thrombosis of left spermatic and cyst of left ovary. Right spermatic ligated and left ovary removed. Recovery.

CASE 40. Reported by Berkofsky 1908. Details not given. Operation after abortion disclosed abscess between coils of intestines and thrombosis of right spermatic. Right spermatic ligated. Patient died. Autopsy revealed peritonitis.

CASE 41. Reported by Williams, 1909. Patient (abortion) had chills daily. Highest temperature was 106° with general condition fair. Operation disclosed thrombosis of right spermatic. Right spermatic was ligated. Recovery.

CASE 42. Reported by Williams, 1909. Patient aged 27 (abortion) had first chill second day followed by chills daily. Highest temperature was 104. General condition of patient poor. Operation disclosed thrombosis of left spermatic. Left salpingitis and pulmonary involvement. Right spermatic was ligated. Recovery.

CASE 43. Reported by Zweifel 1902. Details not given. Operation disclosed thrombosis of superior spermatic. Left spermatic vein was ligated. Recovery.

CASE 44. Reported by Seitz, 1906. Patient aged 23 had chills daily. Operation fourteenth day after symptoms developed disclosed right ovary of greenish color and size of hen's egg. Right sper

matic thrombosed size of thumb tending upward from pelvic rim. Bilateral ligation was performed and double ligation made below the thrombus. Recovery.

CASE 45. Reported by Freund 1908. Patient aged 6 (term) had first chill first day followed by chills daily. General condition bad. Operation 16 days after delivery disclosed right spermatic vein in thrombosed size of thumb up to vena cava. Right spermatic vein was ligated low to vena cava. Could not ligate entirely above thrombus. Result unknown.

CASE 46. Reported by Vansly Wagner 1908. Abort patient had first chill. Highest temperature was 40.6 C. Operation 10 days after onset disclosed thrombosis of left spermatic vein and broad ligament. Left spermatic vein was ligated 1 1/2 inches above site of thrombus. Left broad ligament revealed purulent metritis. Parametrium thrombophlebitis. Left colon extending up to within 1 inch of kidney. Thrombophlebitis in vein of right parametrium. Parametrium ligated. General condition improved. Live and healthy. Pleurisy.

CASE 47. Reported by Vansly Wagner 1908. Patient aged 3 (term) had first chill thirteenth day followed by frequent chills. Highest temperature was 40.4 C. General condition bad. Operation 5 days after onset disclosed thrombosis of right spermatic vein up to renal vein size of finger. Parametrium thrombosis. Left broad ligament revealed diptheritic endometritis. Autopsy revealed pyosalpinx thrombophlebitis of right spermatic vein. Left vena cava spleen tumor fatty degeneration of heart liver and kidneys. Smears from thrombus show streptococci.

CASE 48. Reported by Vansly Wagner 1908. Patient aged 38 (term). Highest temperature was 40.8 C. General condition bad. Operation 9 days after onset. Left spermatic was ligated and left fallopian tube removed. Patient died. Autopsy revealed diptheritic endometritis. Abscess left parametrium, thrombosis of parametrial veins. Fresh thrombus above ligated vein. Degeneration of heart and kidneys. Pyelitis.

CASE 49. Reported by Vansly Wagner 1908. Patient aged 3 (term) had first chill third day followed by chills daily. Highest temperature 4 C. Operation 6 days after onset disclosed thrombosis of right spermatic and serous effusion in abdominal cavity. Uterus appeared normal. Right spermatic and other visible veins of right parametrium were ligated. Patient died. Autopsy 9 days after operation revealed lung infarcts spleen one and one-half normal size. Kidney degenerated. Left ovarian vein by solid thrombus not adherent. Nothing in venous trunk of pelvis.

CASE 50. Reported by Leopold 1908. Patient (term) had chills daily. Temperature was high and general condition bad. Operation 4 days after onset disclosed pleuritis of left side. Thrombosis of both femoral veins. Thrombosis of right spermatic almost to vena cava. Right

spermatic vein was ligated as high as possible and at site of uterus. Recovery.

CASE 51. Reported by Freund 1908. Patient aged 16 (term) had first chill eighth day followed by frequent chills. General condition serious. Operation 24 days after onset of symptoms disclosed right spermatic vein thrombosed almost to vena cava. Right spermatic ligated. Recovery.

CASE 52. Reported by Koblanck 1909. Patient aged 36 (term). Highest temperature was 40 C. Operation 9 days after onset of symptoms disclosed dark serous fluid in abdomen. Left spermatic thrombosed. Left spermatic was ligated but end of thrombus could not be reached. Some thrombosed veins of broad ligament were excised. Peritonitis. Blood sterile. Patient died 11 days after operation. Autopsy revealed peritonitis endometritis (septic) thrombophlebitis of spermatic vein.

CASE 53. Reported by Leopold 1909. Details of general condition. Left spermatic vein was ligated. Recovery.

CASE 54. Reported by Bishop 1909. Patient aged 1 (abortion) had first chill eleventh day followed by many chills. Operation 19 days after onset of symptoms disclosed right broad ligament thickened and edematous. Marked dilatation of vein mostly at other end of ligament. Right infundibulo-ovarian ligament ligated at brim and portion of broad ligament removed. Had severe oozing. Recovery.

CASE 55. Reported by Opitz 1909. Patient (term) had first chill fifth day. General condition serious. Operation 8 days after onset of symptoms disclosed thick gelatinous infiltration of the tissue surrounding the vein. Left spermatic vein was ligated at renal junction. Patient died two days later. Autopsy showed peritonitis.

CASE 56. Reported by Planensiel 1909. Details of general condition. Operation disclosed thrombosis of spermatic. One spermatic ligated. Autopsy revealed double spermatic vein and thrombus in root region of this vein. Thought vena cava ureter.

CASE 57. Reported by Pankow 1909. Patient (term) had first chill second day. General condition serious. Operation 10 days after symptoms of infection disclosed streptococci in blood and thrombosis of left spermatic vein. Left spermatic vein was ligated. Result unknown.

CASE 58. Reported by Klein 1911. Patient aged 23 (term) had first chill thirteenth day followed by frequent chills. Highest temperature was 40.4 C. General condition bad. Operation 5 days after infection developed disclosed right spermatic vein thrombosed size of finger and extending nearly to renal vein. Parametrium edematous. Right spermatic vein ligated close to renal vein. Patient died. Autopsy revealed metrorrhagia pyosalpinx right spermatic vein thrombosed thrombosis reaching into vena cava lung edema degeneration of heart and kidneys streptococci.

CASE 59. Reported by Klein 1911. Patient aged 38 (term) and first chill third day followed

by chills daily. Highest temperature was 40.8°C. General condition serious. Operation ninth day of disease disclosed metrophlebitis cords palpated to left of uterus thrombosis of left spermatic vein. Double ligation of left spermatic vein. Patient died second day. Autopsy revealed abscess in left parametrium small veins thrombosed fresh thrombus above ligature. Heart kidneys lung and brain involved.

CASE 60 Reported by Klein 1911 Patient (term) aged 38 had first chill third day followed by chills daily. Highest temperature was 40.8°C with general condition bad. Operation 9 days after symptoms developed disclosed thrombosis of left spermatic. Left spermatic was ligated and left tube removed. Patient died. Autopsy revealed abscess of left parametrium above ligature thrombus, kidneys and heart degenerated brain oedema pyelitis.

CASE 61 Reported by Miller 1911 Patient aged 19 (full term) had first chill fifth day followed by chills daily. Highest temperature was 106 with general condition bad. Operation 77 days after onset disclosed oedema of right tube and ligament. Left normal right ovarian vein thrombosed size of thumb extending nearly to renal vein hypogastric free. Thrombosed right spermatic vein was ligated above thrombus. Recovery.

CASE 62 Reported by Velt 1912 Patient aged 22 (full term) had first chill fourth day followed by many chills. General condition fair. Operation 6 days after onset of symptoms disclosed right spermatic vein thrombosed periphlebitis with greasy looking exudate blood and smears showed streptococci. Right spermatic vein was ligated. Recovered.

CASE 63 Reported by Velt 1912 Patient aged 25 (full term) had first chill second day followed by frequent chills. Highest temperature was 40.7°C with general condition fair. Operation 5 days after onset of symptoms disclosed thrombosis of right spermatic vein and surrounding tissues oedematous. Right spermatic vein was ligated. Recovery.

CASE 64. Reported by Velt 1912 Patient (full term) highest temperature 40.4°C. Details not given. Operation disclosed thrombosis of right spermatic vein and streptococci in blood. Died following operation.

CASE 65 Reported by Velt 1912 Patient (abortion) had first chill second day followed by frequent chills. Operation fifth day of disease disclosed thrombosis of right spermatic vein up to renal vein. Thrombus was pushed down with finger and right spermatic vein ligated close to renal vein. Chills continued until death on forty-second day. No autopsy.

CASE 66 Reported by Ahrendts 1913 Patient (abortion) had first chill second day. General condition bad. Operation twenty fourth day of disease. Left spermatic vein was ligated and excised. Patient died during operation.

CASE 67 Reported by Sigwart 1913 Patient aged 30 had first chill fourth day followed by chills daily. General condition bad. Operation disclosed thrombosis of right spermatic vein through entire length. Right spermatic vein was ligated close to cava. Right broad ligament and adnexa removed. Immediate improvement with recovery.

CASE 68 Reported by Sigwart 1913 Patient (premature birth) aged 22 had first chill third day followed by frequent chills. Highest temperature was 41°C with general condition bad. Operation 21 days after onset of symptoms disclosed right adnexa thickened and imbedded in gelatinous in duration right spermatic vein thrombosed entire length size of thumb, vessels of right round ligament thrombosed. Right spermatic vein was ligated close to cava and right round ligament was ligated at both ends. No further chills smooth recovery.

CASE 69 Reported by Brown 1914. Patient aged 34 (term) had first chill eighth day followed by frequent chills. Highest temperature was 106.6. Operation 15 days after onset of symptoms disclosed oedema of left tube, ovary and left broad ligament and thrombosis of left spermatic. Left spermatic was ligated and left tube and ovary removed. Recovery.

CASE 70 Reported by Miller 1916 Patient aged 27 (term) had first chill eighth day followed by frequent chills. Highest temperature was 104 with general condition bad. Operation 70 days after onset of symptoms disclosed thrombosis of left ovarian vein with breaking down of the vein and formation of abscess. Vein was ligated above abscess and abscess drained. Patient died. No autopsy.

#### SUMMARY

Total cases 35. Results not given in 1. Of 34 cases 19 recovered, 15 died gross mortality 44.1 per cent. Deduct cases 45, 47 and 65 in which it was impossible to apply the ligature well above the thrombus 37 of acute streptococcemia 40 abscess between coils of intestines, 40 and 52 of peritonitis and 70 of periphlebitic abscess. Corrected mortality 30.7 per cent.

#### SERIES D—TRANSFERRONAL OPERATION LIGATION OR EXCISION BOTH SPERMATIC VEINS AFTER OPERATION

CASE 71 Reported by Opitz, 1905 Patient (abortion) had first chill fifty-seventh day followed by frequent chills. Highest temperature was 41.5°C. General condition serious. Operation 66 days after abortion disclosed thrombosis of both spermatics hypogastrics normal. Both spermatics ligated. Death followed operation. Autopsy revealed thrombus extending above ligature into renal vein on left side.

CASE 72 Reported by Berkofsky, 1908 Patient aged 29 (abortion) had first chill third day followed by chills daily. Highest temperature 42.40°C general condition serious. Operation 31

days after onset of symptoms. Both spermatics ligated. Recovery.

CASE 73. Reported by Berkofsky, 1908. Patient aged 22 had first chill third day after abortion, followed by chills daily. Highest temperature was 39 C. General condition serious. Operation 28 days after onset of symptoms. Pulmonary symptoms. Both spermatics ligated. Recovery.

CASE 74. Reported by Berkofsky, 1908. Details not given. Operation disclosed acute pyemia. Both spermatics in inflammatory tissue ligated. Patient died. Autopsy revealed thrombosis of right femoral, iliac and hypogastric veins.

CASE 75. Reported by Berkofsky, 1908. Details not given. Operation disclosed acute septic pyemia. Both spermatics ligated. Patient died. Autopsy revealed spermatics free thrombosis of both hypogastrics.

CASE 76. Reported by Latske, 1905. Details not given. Patient at term. Operation twenty eighth day after onset of symptoms disclosed thrombosis of both spermatic veins to size of finger. Both spermatics ligated. Recovery.

CASE 77. Reported by Leopold, 1909. Patient aged 33 had first chill eleventh day followed by frequent chills. Highest temperature was 40 C. General condition bad. Operation twenty-sixth day disclosed parametrium infiltrated and streptococci in vaginal secretions. Both spermatics ligated. Death on fifth day following operation. Autopsy revealed phlegmon of retroperitoneal cellular tissue, purulent peritonitis, abscesses in elbow and ankle-joints, thrombosis above ligature in left spermatic, left common iliac thrombosed and full of pus and cherry-sized abscess on outer wall of uterus.

CASE 78. Reported by W. B. Bell, 1909. Patient aged 36 (term) had high temperature with general condition bad. Operation 15 days after onset of symptoms disclosed clear serum in abdomen and right spermatic vein thrombosed size of banana. Right spermatic vein ligated and excised and left spermatic vein excised. Death sixteenth day following operation. Autopsy revealed thrombosis above ligature into cave, uterus empty with no sign of inflammation vein filled with pus.

CASE 79. Reported by Michel, 1909. Patient aged 23 (term), had first chill third day followed by daily chills. Highest temperature was 107 with general condition bad. Operation 18 days after onset of symptoms disclosed thrombosis of left and right ovarian veins both hypogastric veins free. Ligated both ovarian veins but not sure left ligature was above end of thrombus. Two days later retroperitoneal exposure of left vein ligature cut through and pus discharged. Death third day following operation, thirty-second day of disease. Autopsy revealed fatty degeneration of large glandular organs, right ovarian vein with healthy thrombus above and below ligature.

CASE 80. Reported by Brettaner, 1909. Patient (term) aged 21 had first chill fifth day fol-

lowed by chills daily. Highest temperature was 106° with general condition bad. Operation 17 days after onset of symptoms disclosed uterus and adnexa normal no exudate or adhesions hypogastrics free, also median pelvic vein. Both ovarian veins ligated. Death eighth day following operation, thirty-fifth day after delivery. Autopsy revealed ovarian veins filled with fresh uninfected blood, left common and external iliac filled with semifluid purulent material, vena cava thrombosed to diaphragm, lung abscess.

CASE 81. Reported by L. Seltz (from thesis of J. Antoine). Patient had frequent chills with general condition bad. Other details not given. Both spermatics ligated bilaterally. Cessation sixth day. Recovery.

CASE 82. Reported by Bell, 1911. Patient aged 28 (term). Highest temperature was 103 general condition serious. Operation 13 days after onset of symptoms disclosed thrombosis of right ovarian vein. Left ovarian vein markedly engorged. Both spermatic veins and some small veins in broad ligament ligated. Recovery.

CASE 83. Reported by Findley, 1912. Patient had many chills, general condition serious. Operation twenty-first day of disease disclosed no thrombosed veins. Both spermatics ligated. (Does not give operation any credit in this case.) Finally had lung abscess, which was drained. Recovery.

CASE 84. Reported by Huggins, 1912. Patient aged 33 (term) had first chill third day followed by many chills. General condition bad. Operation disclosed left broad ligament infiltrated and left spermatic vein thrombosed for 3 inches. Left spermatic vein ligated. Right spermatic vein ligated as precaution. Pneumonia during convalescence. Recovery.

CASE 85. Reported by Huggins, 1912. Patient (full term) had many chills. General condition bad. Operation disclosed right spermatic vein thrombosed. Streptococci in pus removed from the veins. Both spermatics ligated and right spermatic vein excised. Recovery.

CASE 86. Reported by Velt, 1912. Patient (term) had first chill twelfth day followed by many chills. General condition fair. Operation disclosed right spermatic vein thrombosed. Both spermatic veins ligated. Recovery.

CASE 87. Reported by Velt, 1912. Patient (term) had first chill third day followed by frequent chills. General condition fair. Operation 11 days after onset of symptoms disclosed right spermatic vein thrombosed. Pronounced edema around left spermatic. Both spermatic veins ligated. Had some lung symptoms that gradually disappeared. Recovery.

CASE 88. Reported by Ahrendts, 1913. Patient had first chill third day followed by chills daily. Highest temperature was 40.8°C. Operation sixth day disclosed left adnexa adherent and thrombosed left spermatic vein. Both spermatics ligated and excised with cautery. Death second day following

operation. Streptococci in heart blood and peritoneal pus thrombosis extended into vena cava retroperitoneal abscess.

CASE 89. Reported by Jellett 1913. Patient aged 27 (term) had first chill second day followed by chills daily. General condition fair. Operation 15 days after onset of symptoms. Both ovarian veins ligated. Temperature normal on fourth day. Recovery.

CASE 90. Reported by Schwyzer. Patient (term) had first chill seventeenth day. Highest temperature was 104.1 with general condition fair. Operation 22 days after onset of symptoms disclosed soft uterus, small fibroid abscess on outer wall of pectonemum of iliac fossa, broad ligament infiltrated, right tube contained pus. Right ovarian vein drained and left ovarian vein ligated. No chills after operation. Recovery.

#### SUMMARY

Total cases 20 Recoveries 12 Deaths 8  
Gross mortality 40 per cent. Deduct 2 cases of severe acute pyæmia and 1 of intraperitoneal abscess. Corrected mortality 31.2

#### SERIES 2.—TRANS-PERITONEAL OPERATIONS LIGATION OR EXCISION OF ONE SPERMATIC AND HYPOGASTRIC VEIN AFTER LAPAROTOMY

CASE 91. Reported by Bumm 1905. Patient (term) had first chill eighth day followed by chills daily. General condition poor. Operation 48 days after onset of symptoms disclosed thrombosis of left side and endocarditis. Right spermatic and hypogastric ligated. Patient died. Autopsy disclosed thrombosis of cava and lung abscesses.

CASE 92. Reported by Bumm 1905. Patient aged 33 (abortion), had first chill sixth day followed by chills daily. Highest temperature 40.5 C general condition good. Operation 18 days after onset of symptoms disclosed thrombosis of right side. Right spermatic and hypogastric ligated. Recovery.

CASE 93. Reported by Friedmann, 1908. Patient aged 27 (abortion) had first chill third day followed by chills daily. Highest temperature was 40.8 C general condition good. Operation 31 days after onset of symptoms disclosed thrombosis of left side. Left spermatic and hypogastric ligated. Recovery.

CASE 94. Reported by Williams, 1909. Patient aged 18 (abortion) had first chill eighth day followed by chills daily. Highest temperature was 103.7 with general condition fair. Operation 14 days after onset of symptoms disclosed thrombosis of right side. Right-sided vessels ligated and later broad ligament abscess opened. Recovery.

CASE 95. Reported by Boldt 1905. Patient aged 20 (full term) had many chills. Operation 9 days after onset of symptoms disclosed right horn of uterus indurated, right broad ligament indurated, vessels thrombosed, small abscess found above broad ligament near pelvic bone. Resected right broad ligament with spermatic and iliac veins. Recovery.

CASE 96. Reported by von Herff 1908. Full term. General condition of patient bad. Operation 35 days after onset of symptoms disclosed thrombosis of right hypogastric and surrounded by inflammatory œdema. Right spermatic and right hypogastric ligated. Recovery.

CASE 97. Reported by Hartog 1909. Patient (abortion) had many chills. General condition bad. Operation 28 days after onset of symptoms. Hypogastric and spermatic veins ligated. Temperature normal following day. Recovery.

CASE 98. Reported by Osterloh (op Seidel) 1909. Patient (full term) had first chill fourteenth day followed by chills daily. Highest temperature was 42.6 C. Operation 42 days after onset of symptoms disclosed staphylococœmia, thrombosed right spermatic and right hypogastric veins, vein contained greasy pus, periphlebitic abscess. Right spermatic and right hypogastric veins ligated. Chills continued, with pneumonia. Death sixteenth day following operation. Autopsy revealed vena cava completely filled with thrombus, right spermatic vein completely thrombosed, uterus normal.

CASE 99. Reported by Antoine, 1909. Patient aged 18 (full term), had first chill sixth day followed by chills daily. Highest temperature was 41.4 C. Operation 18 days after delivery disclosed right spermatic thrombosed for 6 centimeters and œdema of right broad ligament. Right spermatic and right hypogastric veins ligated. Pulmonary infarcts. Recovery.

CASE 100. Reported by Opitz, 1909. Details not given. Patient's condition serious (abortion). Operation 15 days after symptoms developed disclosed structures around left hypogastric vein gelatinously infiltrated. Left spermatic and left hypogastric veins ligated. Death third day following operation. Autopsy revealed extension of thrombus into renal vein and cava and that ligation had been done in a soft place.

CASE 101. Reported by Osterloh, 1910. Details not given. Operation twenty-eighth day disclosed hypogastric vein containing pus, which drained out during the operation. Right spermatic and right hypogastric veins ligated. Death seventeenth day following operation. Autopsy revealed cava thrombosed to liver, extended thrombosis in hypogastric, spermatic, and crural veins.

CASE 102. Reported by Veit 1912 (abortion). Patient had chill first day. General condition bad. Operation 9 days after onset of disease disclosed thrombosis of left spermatic vein which extended so high that it was impossible to ligate above it. Left spermatic vein incised and drained, contained pure pus with thrombus, greasy secretion around the veins, right hypogastric ligated. Patient died. Autopsy revealed thrombosis extending into renal vein. (Veit's comment operation too late.)

CASE 103. Reported by Theinhaus 1912. Patient (at term) had first chill fifth day followed by chills daily. Operation 35 days after onset of symptoms disclosed thrombophlebitis and abscess of



right ovary. Veins ligated on right side (details not obtainable.) Death on fourteenth day following operation.

CASE 104. Reported by Ahrendts, 1913. Patient (at term) had first chill eighth day followed by frequent chills. Operation 5 days after onset of symptoms. Right spermatic and hypogastric veins ligated. Death third day following operation. Autopsy revealed gangrenous endometritis, septic thrombophlebitis, purulent peritonitis, lung abscess.

CASE 05. Reported by Miller, 96. Patient aged 3 (at term) had first chill seventh day followed by frequent chills. Highest temperature was 106° with general condition fair. Operation 2 days after onset of symptoms disclosed right hypogastric and right ovarian veins thrombosed, small amount of pus in right tube, marked edema of perivascular tissues, two periphlebotic abscesses along the ovarian vein. Ligation of right ovarian vein about 2 inches from vena cava. Ligation of hypogastric vein. Found later that the right ureter had either been ligated or punctured, fistula developed at site of drain 2 days after operation. Right kidney removed November, six weeks after first operation. Found to contain multiple abscesses. Recovery.

#### SUMMARY

Total cases 5. Recoveries 0. Deaths 5. Gross mortality 100 per cent. Deduct Case 05 of abscess with staphylococci 10 in which it was impossible to ligate above the thrombus, 05 of abscess, 01 of endocarditis, 103 of ovarian abscess. Corrected mortality 100 per cent.

#### SERIES 7—TRANSFEROXAL OPERATIONS—LIGATION BOTH SPERMATICS AND ONE HYPOGASTRIC VEIN AFTER LAPAROTOMY

CASE 106. Reported by Friedman, 1906. Patient aged 7 (abortion) had first chill sixth day followed by chills daily. Highest temperature was 105.8° C. general condition serious. Operation 36 days after onset of symptoms disclosed fourteenth day pulmonary embolism, later abscess. Both spermatics and right hypogastric ligated. Recovery.

CASE 07. Reported by Fromm, 1907. Patient aged 34 (abortion) had first chill ninth day followed by chills daily. Highest temperature was 41° C. general condition serious. Operation 38 days after onset of symptoms. Right parametrial abscess opened twenty-fifth day. Both spermatics and right hypogastric ligated. Patient died. Autopsy revealed pulmonary abscess, pleurisy, cava thrombosis, nephritis three weeks after operation.

CASE 108. Reported by Leopold, 1909. Patient (term) aged 18 had first chill eighth day. Highest temperature was 40.9° C. general condition bad. Operation 43 days after onset of symptoms disclosed lung embolism 3 days before operation. Spermatic vein thickened on both sides, hypogastric vein filled with thrombus mass vein and artery so

fused that they could not be recognized separately. Double ligation of spermatics and left external iliac. Death first day following operation. Autopsy revealed lung infarcts, embolism of pulmonary artery, purulent pleuritis, vena cava filled with thrombus and pus. It was found that iliac artery had been ligated instead of iliac vein.

CASE 109. Reported by Doderlein (thesis J. Antoine). Details not given. Patient had chills daily with general condition serious. Both spermatics and left hypogastric ligated. Patient died.

CASE 008. Reported by Veit, 1913. Patient (abortion) had chills daily. Details not given. Operation 1 day after onset of symptoms. Both spermatics and right hypogastric ligated. Patient died. Autopsy revealed that a large accessory vein had been ligated instead of hypogastric. Actual hypogastric contained a thrombus which extended into cava. Mistake due to marked edema of pelvic structures.

CASE 10. Reported by Veit, 1912. Patient (at term) had first chill fifteenth day followed by chills daily. General condition fair. Operation 13 days after onset of symptoms disclosed peritonitis. Turbid fluid flowed from right pelvic connective tissue. Both spermatics and one hypogastric ligated. Patient died. Autopsy showed thrombi in veins of uterus.

CASE 111. Reported by Ahrendts, 1913. Patient (at term) had first chill third day. Highest temperature was 41.1° C. general condition bad. Operation 33 days after onset of symptoms disclosed veins of parametrium thrombosed. Both spermatics ligated and excised, left hypogastric ligated. Convalescence tedious.

CASE 1. Reported by Ahrendts, 93. Patient (abortion) had first chill seventh day. Highest temperature was 40.7° C. Operation 8 days after onset of symptoms. Right spermatic ligated and excised, right hypogastric ligated. Prompt improvement with recovery.

CASE 113. Reported by Brix, 913. Patient aged 42 (abortion) had first chill third day followed by frequent chills. Highest temperature was 40° C. general condition fair. Operation 21 days after onset of symptoms. Both hypogastrics and one iliac ligated owing to hemorrhage. Recovery.

#### SUMMARY

Total cases 9. Recoveries 4. Deaths 5. Gross mortality 55.5 per cent. Case 07 of parametrial abscess, 03 pulmonary infarcts, 110 peritonitis. Corrected mortality 33.3 per cent.

#### SERIES 8—TRANSFEROXAL OPERATIONS—LIGATION OR EXCISION OF BOTH SPERMATIC AND HYPOGASTRIC VEINS AFTER LAPAROTOMY

CASE 4. Reported by B. mm, 1903. Patient aged 20 (term) had first chill second day followed by chills daily. Highest temperature was 4° C. general condition fair. Operation 64 days after onset of symptoms disclosed peritonitis. Vessels on

right side thrombosed Drainage for peritonitis fourth day Both spermatics and hypogastric ligated. Recovery

CASE 115 Reported by Bumm, 1905 Patient aged 22 (term) had first chill twenty-seventh day followed by chills daily Highest temperature was 41.5 C general condition fair Operation 34 days after onset of symptoms. Both spermatics and hypogastrics ligated. Marked swelling of genitalia. Recovery

CASE 116 Reported by Haeckel, 1905. Patient aged 42 had first chill twenty fourth day followed by chills daily Highest temperature was 39.6°C. with general condition poor Operation 44 days after removal of hydatid mole disclosed veins thrombosed Both spermatics and hypogastrics ligated. Prompt recovery

CASE 117 Reported by Haeckel, 1905 Patient aged 31 (term) had first chill fifth day followed by chills daily General condition of patient serious. Operation disclosed acute pyæmia and pneumonia. Both spermatics and hypogastrics ligated later common iliac. Patient died. No autopsy

CASE 118 Reported by Fromme, 1907 Patient aged 28 (term) had first chill third day followed by frequent chills. Highest temperature was 40.8°C general condition serious. Operation 12 days after onset of symptoms disclosed acute pyæmia. Double sided ligation. Recovery

CASE 119 Reported by Berkofsky 1908 Patient was operated on after abortion. Other details not given Operation disclosed acute septic pyæmia Double-sided ligation. Result not stated. Patient died.

CASE 120 Reported by Bardeleben, 1908 Patient aged 22 (term) had first chill fifteenth day followed by many chills. Highest temperature was 40 C general condition serious. Operation 10 days after onset of symptoms. Double sided ligation. Recovery

CASE 121 Reported by Bardeleben, 1908 Patient aged 31 (abortion) had first chill thirteenth day followed by 54 chills. Highest temperature was 40 C general condition serious. Operation 30 days after onset of symptoms disclosed thrombosis of left side Both spermatics and both hypogastric arteries and veins ligated. Recovery

CASE 122 Reported by Menge 1900 Patient's general condition serious. Other details not given. Operation disclosed severe septic thrombophlebitis. Both spermatic veins and both hypogastric veins ligated Recovery

CASE 123 Reported by Lamels 1911 Patient (at term) had first chill second day followed by chills daily Highest temperature was 41 C general condition bad Operation 5 days after onset of symptoms disclosed uterus relaxed peritoneum clean right adnexa and parametrium oedematous right spermatic and hypogastric veins thrombosed, oedema of lower half of body Spermatic vein and right and left hypogastrics ligated. Three chills after operation. Recovery

CASE 124. Reported by Veit, 1912 Patient (at term) had first chill third day followed by chills daily General condition fair Operation 12 days after onset of symptoms disclosed right spermatic vein filled with thrombus left hypogastric vein suspicious of thrombus. Both spermatics and both hypogastrics ligated. Recovery

CASE 125 Reported by Veit 1912 Patient (abortion) had first chill fourteenth day followed by frequent chills. General condition of patient bad. Operation 22 days after onset of symptoms disclosed thrombosis of left broad ligament veins on left slight oedema of right broad ligament blood showed hæmolytic streptococci. Recovery

CASE 126 Reported by Veit 1912 Patient aged 31 (at term) High temperature. Operation disclosed streptococæmia no thromboses. Ligation of the four veins. Death first day after operation Autopsy revealed general blood sepsis no thrombophlebitis.

CASE 127 Reported by Ahrendts 1913 Patient (at term) had chills daily Highest temperature 41.9 C Operation 63 days after onset of symptoms disclosed soft indistinct cords in parametrium and purulent discharge from punctures in lateral hypogastric region. Both spermatics and hypogastrics ligated. Convalescence tedious.

CASE 128 Reported by Ahrendts, 1913 Patient (abortion) had chills daily Highest temperature was 40.6 C Operation 29 days after onset of symptoms. Left spermatic and both hypogastrics ligated. Patient died. Autopsy revealed thrombosed vena cava purulent pleuritis lung embolism abscesses.

CASE 129 Reported by Ahrendts, 1913 Patient (abortion) had first chill fifth day followed by chills daily Highest temperature was 41.5°C general condition bad. Operation 18 days after onset of symptoms disclosed thrombosis of right spermatic vein Both spermatic veins ligated and resected both hypogastrics ligated. Septic thrombosis of left vein hypogastric and common iliac. Patient died tenth day following operation. Autopsy revealed thrombosis of right spermatic endocarditis peritonitis spleen enlarged.

CASE 130 Reported by Doderlein, 1914. Details not given. Both spermatic and hypogastric veins ligated. No chills after operation. Recovery

#### SUMMARY

Total cases 17 Recoveries 12 Deaths 5 Gross mortality 29 per cent. Deduct cases 117 and 118 and 126 of acute pyæmia. Corrected mortality 8.3 per cent.

#### SERIES II.—TRANS-ABDOMINAL OPERATIONS. LIGATION OR EXCISION OF ONE HYPOGASTRIC VEIN AFTER LAPAROTOMY

CASE 131 Reported by Bumm, 1905. Patient aged 27 (at term) had first chill seventeenth day followed by repeated chills. Highest temperature 42.3 40 C. with general condition poor Operation

56 days after onset of symptoms. Left hypogastric vein ligated. Patient died. Autopsy revealed peritonitis, cava thrombosed infarcts in various organs, pneumonia.

CASE 132 Reported by Latzo 1907 Details not given. Hypogastric artery and vein on one side ligated removed thrombosed vessels through vagina. Patient died 5 weeks later with hemorrhage from hypogastric artery.

CASE 133 Reported by Brothers 1907 Details not given. Hypogastric vein ligated. Patient died.

CASE 134 Reported by Martin, 1908 Details not given. Operation disclosed vein thrombosed which unites venous vessels from the bladder (not Kanatsky's median vein). Patient died.

CASE 35 Reported by Ahrendts 1909 Details not given. Left hypogastric ligated. Patient died. Autopsy revealed complete thrombosis of vena cava starting in external iliac.

CASE 136 Reported by Koblanck 1909 Patient aged 3 (abortion) had first chill seventh day followed by frequent chills. General condition bad. Operation 35 days after onset of symptoms. Left hypogastric vein ligated. Chills continued after operation, with death seventh day. Autopsy revealed left purulent parametrium ligated hypogastric vein contained purulent thrombus extending to vena cava.

CASE 137 Reported by Parache (op. Recasens), 1909 Details not given. Operation disclosed peritonitis thrombophlebitis pelvic cellulitis. Both hypogastrics ligated. Result of operation unknown.

CASE 38 Reported by Beutner 1911 Patient had frequent chills with general condition bad. Operation disclosed parotid metastases. Right hypogastric vein ligated. Patient died.

CASE 139 Reported by Thorn, 1912 General condition of patient serious. Other details not given. Operation disclosed thrombosed hypogastric vein thrombophlebitis. Hypogastric vein and surrounding tissue excised. Recovery.

CASE 140 Reported by Veit 19 Patient (at term) had first chill second day, followed by frequent chills. General condition of patient bad. Operation 9 days after onset of symptoms disclosed septic fluid in abdominal cavity thrombosis of left iliac vein (peritonitis). Left iliac vein ligated. Patient died. Autopsy revealed thrombus extending from ligation up into vena cava.

CASE 41 Reported by Veit, 1913 Patient (at term) had first chill third day. Operation 14 days after onset of symptoms disclosed thrombosis of left iliac vein. Left iliac vein ligated. Death sixth day following operation. Autopsy revealed septic phlebitis of left ovarian vein and spleen tumor.

CASE 4 Reported by Veit, 9 Patient (at term) had first chill fifth day followed by chills daily. Temperature was high with general condition fair. Operation disclosed abscess forming around the thrombosed hypogastric vein. Right hypogastric vein ligated. Patient died.

CASE 143 Reported by Ahrendts 1913 Pa-

tient (at term) had first chill second day followed by frequent chills. Highest temperature was 40.8° C with general condition bad. Operation 47 days after onset of symptom. Left hypogastric vein ligated. Patient died. Autopsy revealed purulent pleuritis and septic thrombus extending into vena cava.

CASE 144 Reported by Vanverts, 1913 Patient aged 3 (at term) had frequent chills. Highest temperature was 40° C with general condition fair. Operation 30 days after onset of symptoms disclosed hypogastric thrombosed and abscess of broad ligament. Right hypogastric vein ligated. Died.

#### SUMMARY

Total cases 14. Recoveries 1. Deaths 12. Result not stated in 1 case. Mortality 92 per cent. Deduct Cases 38 and 41 of peritonitis, 143 of abscess, 145 of broad ligament abscess. Corrected mortality 80 per cent.

#### SERIES I—TRANSFIBROUS OPERATIONS. NO DETAILS GIVEN

CASE 145 Reported by Latzo 1907 Patient died.

CASE 146 Reported by Latzo 1907 Patient died.

CASE 14 Reported by Latzo 1907 Recovery.

CASE 148 Reported by Gukedardi, 1908. Recovery.

CASE 149 Reported by George Noble, 1906

CASE 150 Reported by George Noble, 1906

CASE 151 Reported by George Noble, 1906

CASE 52 Reported by George Noble, 1906

CASE 153 Reported by Latzo. Patient died.

CASE 154 Reported by Latzo. Patient died.

CASE 155 Reported by Spitz, 1909. Operation disclosed highly virulent thrombophlebitis with acute pyemia. Patient died.

CASE 56 Reported by Pfannenstiel, 1909. Veins ligated. Patient died.

CASE 157 Reported by Pfannenstiel, 1909. Veins ligated. Patient died.

CASE 158 Reported by Pfannenstiel, 1909. Veins ligated. Patient died.

CASE 159 Reported by Pfannenstiel, 1909. Veins ligated. Patient died.

CASE 160 Reported by von Rosthorn, 1909. Venous ligation. States operation too late. Patient died.

CASE 16 Reported by Koblanck, 1913. Veins excised. Recovery.

#### SUMMARY

Total cases, 17. Recoveries, 3. Deaths, 0. Results not given in 4 cases. Mortality 76.9 per cent.

#### SERIES J—TRANSFIBROUS OPERATIONS. LIGATION OR EXCISION OF ONE SPERMATIC WITH ONE COMMON ILIAC VEIN

CASE 62 Reported by Doderlein 1907 Patient (abortion) had chills daily with general con-

Summary of Transperitoneal Operations	Total Operations	Total Deaths	Gross Mortality	Favorable Cases	Deaths	Corrected Mortality per cent	
One spermatic vein excised	35	7	5	30	4	30	No details given in case
One spermatic vein ligated	35	15	44	26	7	26.8	No details in case
Ligation or excision of both spermatics	30	8	40	5	4	5	
Ligation or excision of one spermatic and one hypogastric	5	6	40	10			
Ligation or excision of both spermatics and one hypogastric	0	8	35.5	6		33.3	
Ligation or excision of both spermatics and hypogastrics	7	5	29			8.3	
Ligation or excision of one hypogastric	4		98.8		8	80	Results not given in case
Ligation or excision of one spermatic and common iliac	4		7.4		7	66.6	Results not given in case
Ligation of vena cava	6	8	83.3				
No details	7	10	76.9				Results not given in 4 cases
Average percentage (vena cava series and four in which no details were given not included)			5.6			33.9	
Total	8	91			44		

dition bad. Operation third week disclosed common iliac adherent to vena inferior right-sided pleural exudate. Common iliac ligated. Patient died.

CASE 163 Reported by Fromme 1909 Patient aged 33 (abortion). Highest temperature was 39.9 C with general condition bad. Operation 7 days after onset of symptoms disclosed spermatic and pelvic veins free streptococci found in blood left ligament swollen icterus peritonitis. Common iliac ligated. Death ninth day following operation. Autopsy revealed lung abscess left common iliac left hypogastric and left femoral veins filled with disintegrated thrombi pneumonic foci.

CASE 164. Reported by Latsko 1909. No details given. Operation disclosed metrophlebitis. Left common iliac ligated. Result unknown.

CASE 165 Reported by Henkel, 1909. No details given. Patient had already lost one eye by metastatic abscess. Common iliac ligated close to vena. Recovery.

CASE 166 Reported by Pfannenstiel 1909. No details given. Common iliac ligated. Patient died. Autopsy showed sacralis lateralis ligated instead of common iliac was size of thumb and branched from vena cava.

CASE 167 Reported by Antoine 1909 Patient aged 37 (abortion) had first chill fifth day followed by many chills. General condition bad. Operation 8 days after onset of symptoms disclosed thrombosis of right spermatic vein, and general periphlebitis about pelvic veins on right side. Right spermatic vein ligated large branch to uterus which might have been median vein ligated left common iliac ligated failed to isolate right hypogastric. Death eighth day following operation. Autopsy revealed diffuse peritonitis, thrombus above right spermatic vein ligature median vein found ligated.

CASE 168 Reported by Veit 1910 Patient had first chill twelfth day followed by many chills, with general condition bad. Operation 14 days

after onset of symptoms. Blood showed streptococci. Spermatic vein left common iliac and right hypogastric veins ligated. Improved 2 days chills subsided but returned blood cultures positive hysterectomy performed. Death following operation. Autopsy revealed small spleen and disintegrating thrombus above ligature.

CASE 169 Reported by Beutner 1911 Abortion. General condition bad. Other details not given. Operation disclosed typical pyæmia. Right common iliac ligated. Recovery.

CASE 170 Reported by Warnekros 1912 General condition of patient serious. Operation twenty-eighth day of disease disclosed common iliac thrombosed and streptococæmia. Common iliac vein ligated. Prompt improvement for 12 days then showed peritonitis. Patient died. Autopsy revealed parametric abscess broken through into peritoneum.

CASE 171 Reported by Warnekros, 1912 Patient had chills daily with general conditions serious. Operation seventeenth day disclosed streptococæmia and thrombosed common iliac. Common iliac vein ligated. Streptococci disappeared from blood. Death from pneumonia twelfth day following operation. Ligature found to have excluded pus foci from circulation.

CASE 172 Reported by Warnekros (op Sig wart) 1912 Patient aged 19 (term) had first chill fifteenth day followed by chills daily. Highest temperature was 40.6 C with general condition of patient bad. Operation 28 days after onset of symptoms disclosed streptococæmia thrombosed left common iliac entire left parametrium infiltrated with gelatinous material. Left common iliac vein ligated. Autopsy revealed entire vena cava filled with thrombus parametric abscess both femoral veins thrombosed pus in left pleura.

CASE 173 Reported by Wallace, 1912 Patient aged 25 (term) had chills daily. Highest

temperature was 106 with general condition of patient bad. Operation 3 days after onset of symptoms disclosed thrombosis of left hypogastric marked edema of parametrium, which made dissection very difficult. Left common iliac ligated. Death from exhaustion after numerous chills and high temperature.

CASE 74 Reported by Fromme, 93. Details not given. Operation disclosed thrombosis of common iliac. Common iliac ligated close to vena cava. Death twelfth day following operation. Autopsy revealed large lung abscesses.

CASE 75 Reported by Kroeber, 1914. Patient aged 32 (term) had frequent chills, with general condition bad. Operative details not given but thrombosed right spermatic mentioned. Both spermatics ligated and excised entire length left hypogastric and right common iliac veins ligated. No chills after operation. Recovery.

CASE 16 Reported by Koblanck, 909. Patient aged 28 (abortion) had frequent chills. Highest temperature was 4 C with general condition bad. Operation 3 days after onset of symptoms disclosed external iliac thrombosed, edema of left ligament and staphylococemia. Left external iliac excised. Death third day following operation. Autopsy revealed myocarditis abscesses in both kidneys purulent thrombus of left ilia and left spermatic veins up to cava.

#### SUMMARY

Total cases 15 Recoveries 3 Deaths 12 Result not given in one case Gross mortality 74 per cent. Cases 63, 64 and 168 could hardly be included in surgical statistics. Corrected mortality 66.6 per cent.

#### SERIES K.—TRANSFEMORAL OPERATIONS. LIGATION OF VENA CAVA BY LAPAROTOMY

CASE 77 Reported by Warnick, 92. Details not given. Operation disclosed thrombosis of vena cava. Patient died. Autopsy revealed thromboses in right uricle of heart.

CASE 178 Reported by Warnick, (op. Bumm), 92. Patient aged 36 (at term) had first chill eighth day followed by chills daily. Highest temperature, 4 C. Operation 3 days after onset of symptoms disclosed thromboses of right common iliac vein. Vena cava ligated. Died of lung embolism on same day. Autopsy revealed pleurisy septic spleen fatty liver no thrombus above ligation. Right common iliac completely obliterated, by thrombus which extended into femoral vein. Below knee left-sided vessels free.

CASE 79 Reported by Fromme, 94. Patient aged 24 (abortion) had chills daily. Operation 10 days after onset of symptoms disclosed complete thrombosis of right common iliac (cm) into vena cava. Vena cava ligated. Death twenty-fifth day. Autopsy revealed vena above ligation normal infectious process had passed over to left common iliac and by circuitous route had reached the heart.

CASE 180 Reported by Trendelenburg, 1906. No details given. Operation disclosed thrombus of common iliac extending short distance into vena cava. Vena cava ligated. Patient lived 6 days.

CASE 181 Reported by Trendelenburg, 1906. No details given. Vena cava ligated. Patient lived 13 days.

CASE 182 Reported by Trendelenburg, 1910. No details given. Operation disclosed acute pyemia. Vena cava ligated. Patient recovered.

#### SUMMARY

Total cases, 6 Recoveries, Deaths, 5 Mortality 83 per cent

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## THE TREATMENT OF PUERPERAL PYÆMIA<sup>1</sup>

By BARTON COOKE HIRST A.B. M.D. LL.D. F.A.C.S. PHILADELPHIA

WE are indebted to Dr. Miller for the presentation of a subject of interest to the profession but on which its judgment is still suspended. In certain ecclesiastical discussions an individual is appointed as the devil's advocate to take the wrong side of a religious question. I fear that my friend Dr. Miller may look on me as playing such a rôle.

I have been opposed to an operation of this kind for the reasons he mentioned in his paper. First the difficulty of diagnosis. I have never been sure that I could detect thrombosis of the pelvic vessels. Second I have also thought that if thrombosis occurred in these vessels it was a conservative action on the part of nature and had better not be disturbed.

A third reason I have had for not utilizing this operation is that nothing apparently could have been gained by it in conditions seen in the performance of a number of pelvic and abdominal operations for puerperal infection during the past twenty five years.

Dr. Piper, one of the staff of the University Maternity, kindly collected for me the records

of our operations during the past five years. It appears that in that period 37 abdominal operations were performed for different types of infection. A list of these cases is appended showing the kind of cases that we regard as requiring such an operation.

Now in the course of this experience as during the years which preceded it we had the opportunity naturally to look inside the abdomen of many infected women and I do not remember seeing any cases in which it occurred to me an advantage might be gained by the ligation of the pelvic veins.

The mortality of this operation too has been discouraging. Dr. Miller presents a more favorable record than I had expected, but nevertheless the mortality remains exceedingly high and the question must be considered whether these women might not have had as good or even a better chance to recover without operative interference.

After carefully considering the subject and reading what literature upon it was available to me, I had regarded the matter as a thing adjudged and had practically discarded it from my mind. But after hearing the schol-

<sup>1</sup>Decreases of paper entitled "Ligation or Excision of the Pelvic Veins in the Treatment of Puerperal Pyæmia," read by Dr. C. Jeff Miller before the Clinical Congress of Surgeons of North America, Philadelphia, October 3-6-14.

arly address to which we have just listened I was impressed with the thought that I shall feel compelled to take up the consideration of this subject once more. I shall certainly look for the symptoms of thrombosis of the pelvic veins in our cases of puerperal pyæmia and I must consider more carefully than I have in the past, the propriety of an operation but I am still not quite convinced though more open to conviction after hearing Dr Miller's paper than I was before.

The accompanying case histories are those of all the cases operated on for puerperal infection in the maternity clinic in the period from April 1 1910 to April 1 1916. There were 37 cases in all with 5 deaths or a mortality of 13.5 per cent. Of these cases 28 were operated on by Dr B. C. Hirst with three deaths or a mortality of 10.7 per cent.

The indication for operation in practically all cases was the presence of a pelvic mass with the history of infection. In two of the cases there was distinct evidence of general peritonitis, and these were only operated on as a forlorn hope.

The location of pain was as follows—left lower abdomen, 13; right lower abdomen, 6; bilateral lower abdomen, 11; not given 7.

The time intervening between delivery (or miscarriage) and operation ranged from three days to five months the majority of cases being from one to three weeks.

The operations that were performed were

Case

Simple drainage of abscess	11
Hysterectomy with glass tube and gauze.	3
Bilateral salpingectomy with glass tube and gauze	2
Right salpingectomy with glass tube and gauze	4
Left salpingectomy with glass tube and gauze	1
Bilateral salpingo-oophorectomy glass tube and gauze	5
Right salpingo-oophorectomy glass tube and gauze	4
Left salpingo-oophorectomy glass tube and gauze	5
Partial hysterectomy and salpingectomy tube and gauze	1
Drainage for peritonitis.	1

Cornual abscess occurred in 11 cases Septic metritis in 2 cases one of which died

and the other recovered. The patients (5) that died are Nos 3 8 13, 27 32 in the accompanying histories

CASE 1. D. F., admitted April 11 1910. History. Six weeks before admission patient was delivered. Soon after her delivery she was seized with chills, fever and pain in lower abdomen. Operation pelvic abscess, partial hysterectomy and salpingectomy: glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 2. R. S., admitted July 4, 1910. History. Five months before admission was delivered of her first child. Three days after delivery began to have pain in left lower abdomen, chills and fever. She has been growing steadily worse from time to time. Operation pelvic abscess, left salpingo-oophorectomy: glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 3. L. O., admitted August 1 1910. History. Aborted a week before admission. Some bleeding since and a malodorous discharge. Fever and pain in lower left abdomen, which at times is very acute. Operation abscess involving right tube and ovary right salpingo-oophorectomy glass tube and gauze drainage. Result death 17 days after operation. Operator Dr John Hirst.

CASE 4. H. G., admitted October 10 1910. History. Miscarried three weeks before admission. Moderate hemorrhage day of admission. Very slight fever. Pain and tenderness in left side for two weeks. Operation bilateral salpingo-oophorectomy: glass tube and gauze. Result recovered. Operator Dr B. C. Hirst.

CASE 5. B. M., admitted January 7, 1911. History. Nine days after delivery after she had been working for some days began to have chills, sweats and fever. Next day pain developed on left side. Examination bilateral mass. Operation, January 17 abdominal section—abscess in both cornu, large abscess in left broad ligament. Partial hysterectomy appendectomy suprapubic glass tube and packing of gauze. Result recovered. Operator Dr B. C. Hirst.

CASE 6. M. M., admitted April 4 1911. History. Delivered less than a month before admission. No further history. Tenderness in left iliac fossa. Operation abscess of left cornu of uterus drained, glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 7. L. L., admitted April 23 1911. History. Discharged from hospital a week before readmission, in apparently good condition. Has had pain in left side since delivery but apparently not severe until a day or so before readmission. Operation abscess in right cornu of uterus, acute appendicitis. Appendectomy right salpingectomy and excision of abscess in right cornu glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 8. J. McG. admitted April 24, 1911. History. Delivered four days before admission by midwife. In labor 24 hours. Three days later developed chills and fever. Diagnosis puerperal sepsis. Operation septic metritis found. Abdominal hysterectomy, glass tube and gauze pack. Result death. Operator Dr B. C. Hirst.

CASE 9. R. Z., admitted May 13, 1911. History. Following delivery five weeks before admission patient had fever later followed by pain in right side. Operation abscess in right cornu of uterus and acute appendicitis. Abscess drained, appendectomy glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 10. S. P. admitted November 11 1911. History. Two weeks after delivery she was admitted. After four days here she seemed to be in good condition and was discharged. Following her discharge she was up and

around for week, and then developed pain in right side with temperature up to 5. Operation right cornual abscess and right salpingitis. Right salpingectomy and excision of cornual abscess glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 3. M. G. admitted November 26, 9. History: Three weeks before admission, missed period, and immediately began to take medicine to terminate pregnancy. A week later began to bleed, which has continued until admission. Two days before admission developed severe pain in right side, at which time she vomited. Pain since. Examination: rigidity, tenderness, definite mass posterior to cervix. Temperature pulse 98, white blood corpuscles 8,000. Operation November 30. Inflammation, mass including both tubes and ovaries and tying down sigmoid double salpingo-oophorectomy. Result recovered. Operator Dr B. C. Hirst.

CASE 4. R. G. admitted January 9. History: Admitted as case of puerperal sepsis four weeks after delivery. Spoke no English. Operation: Abscess involving right ovary tube and broad ligament, and tying down loops of intestines. Right salpingo-oophorectomy. Adhesions freed. Denuded areas on intestines sutured. Glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 5. L. M. admitted April 4, 9. History: Patient delivered two days before admission. Suffered from after pains for 24 hours. Since the complaints only of extreme weakness. Examination: abdomen distended, tympanic and rigid. Tender. A peristaltic operation: abdomen opened found filled with pus. Glass tube and gauze pack. Result death following day. Operator Dr B. C. Hirst.

CASE 6. M. J. admitted June 9. History: Patient pregnant four months. Four days before admission attempted to induce abortion on herself by passing an orange stick into her uterus. Her doctor attempted to clean her out at home but on day of admission, as taken with chills and fever. Operation: bilateral salpingo-oophorectomy. Result recovered. Operator Dr B. C. Hirst.

CASE 7. I. S. admitted June 9. History: Ten days after delivery patient had pain low down on both sides of abdomen. This occurred six weeks ago at which time she delivered seven months' baby. On admission some elevation of temperature and pulse. Examination showed some infiltration of broad ligament. Operation: bilateral salpingectomy glass tube and gauze drainage. Result recovered. Operator Dr John Hirst.

CASE 8. L. G. admitted June 9. History: Ten days after birth of child when up and around she was suddenly seized with chills and fever with pain in back and abdomen. Bloody discharge during week before admission. Operation: right salpingectomy glass tube and gauze drainage. Result recovered. Operator Dr J. H. Hirst.

CASE 9. M. M. admitted July 24, 9. History: Five days after delivery of child came down with chills and fever and pain in back and abdomen. Has had septic fever ever since but the pain has disappeared. Operation: right salpingectomy, glass tube and gauze drainage. Result recovered. Operator Dr J. H. Hirst.

CASE 10. J. E. admitted November 5, 9. History: Since delivery has had fever and pain in left iliac fossa, up until the time of admission. Operation: left salpingo-oophorectomy glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 11. F. F. admitted December 6, 9. History: One week after delivery of child, at her home, had chills accompanied by high fever and later developed pain in lower left side of abdomen, which continued for some

weeks previous to admission. Examination: blood culture negative, white blood corpuscles, 3,600. Operation: suppurative metritis, hysterectomy glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 12. A. S., admitted January 30, 9. History: Delivered three weeks before admission. Three days after baby was born, began to have backache pain in lower abdomen and high fever. On admission, Operation: bilateral cornual abscess—double salpingectomy glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 13. J. P. admitted January 3, 9. History: Five weeks before admission delivered of her first child. For some years previous to birth of child has had cramp-like pain in low abdomen at time of her periods. Since confinement has noticed swelling of feet and increasing general weakness. Examination reveals a hard movable mass in Douglas cul-de-sac. Operation: pelvic inflammation involving right cornu, tube, and ovary—right salpingo-oophorectomy including right cornu, appendectomy glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 14. E. S. admitted February 24, 9. History: One month before admission patient as delivered. Three days after delivery patient began to have pain in right lower abdomen accompanied by high fever. Delivery and curettage done. Her home three weeks before admission. On admission had pain, tenderness and rigidity over right lower quadrant. Temperature between 99 and 100. Operation: evacuation of right cornual abscess, glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 15. R. P. admitted March 9, 9. History: Three months before admission, patient gave birth to child, following which she was in bed for three weeks with pain in both sides of lower abdomen. Three weeks before admission had generalized pain, which in two days localized in right iliac fossa, and this has continued ever since. Temperature normal. Operation: right salpingo-oophorectomy glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 16. S. L. admitted March 30, 9. History: One week before admission, patient as delivered. Three days following delivery seized with pain in right lower quadrant of abdomen. Temperature little above 99. White blood corpuscles 6,000. Operation: right cornual abscess evacuated glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 17. M. H. admitted April 30, 9. History: One week before admission, patient delivered of still-born child, since which time she has fever on admission. Operation: incision of right cornual abscess. Glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 18. M. K. admitted June 9, 9. History: One week before admission patient as delivered. Temperature on admission. Tenderness over lower left quadrant of abdomen. Operation: left salpingectomy glass tube and gauze drainage. Result recovered. Operator Dr B. C. Hirst.

CASE 19. H. F. admitted September 5, 9. History: One week following delivery in her home began to have abdominal pain and high fever which has grown steadily worse. Operation: very large pelvic abscess, incised and glass tube and gauze drainage instituted. Result death the day of operation. Operator Dr John C. Hirst.

CASE 20. E. B., admitted December 8, 9. History: Seven days after delivery which occurred five weeks before admission, felt sharp pain in right iliac fossa, which lessened somewhat, but has persisted. Temperature 99.

white blood corpuscles 18,800. Mass in right side of uterus. Operation right salpingo-oophorectomy appendectomy glass tube and gauze drainage. Result recovered. Operator Dr B C Hirst.

CASE 29 S C. admitted December 28 1914. History Patient, upon finding that her period was some days overdue took various medicines internally to bring on abortion. No record of any instrumental interference. Four days later had chills, fever and intense pain in right iliac fossa. Temperature 100 to 101. White blood corpuscles 30,200. Bilateral mass. Operation bilateral pus tubes drained with glass tube and gauze. Result recovered. Operator Dr N L Knipe.

CASE 30 M S. admitted February 6 1915. History Immediately following confinement three weeks before admission was seized with bilateral lower abdominal pain with fever, chills and sweats. Examination showed tender mass in front of uterus and behind bladder. Operation half Pfannenstiel incision on right side. Cellulitis of uterovaginal space. Rubber tube drainage. Result recovery. Operator Dr B C Hirst.

CASE 31 M M. admitted March 17 1915. History History has been misplaced, but from the record of the operation the case was a puerperal sepsis with cornual abscess. On admission temperature was 102.2. Operation glass tube and gauze drainage of abscess. Result recovered. Operator Dr B C Hirst.

CASE 32 A C., admitted April 1 1915. History Six days following birth of child, which occurred three weeks before admission, began to be troubled with pain in the left lower abdomen, accompanied by nausea, distention and fever. Examination disclosed large mass in left broad ligament. Temperature 103. White blood corpuscles 25,000. Operation bilateral salpingo-oophorectomy glass tube and gauze drainage. Result death. Operator Dr B C Hirst.

CASE 33 J K. admitted April 4, 1915. History Ever since birth of child eight weeks ago has complained of pain in left lower abdomen. Tender mass in left side of

uterus. White blood corpuscles 18,000. Operation left salpingo-oophorectomy glass tube and gauze drainage. Result recovered. Operator Dr B C Hirst.

CASE 34 A S. admitted April 7 1915. History Three weeks before admission, patient induced abortion on herself with slippery elm stick. Following this she bled constantly for two weeks and had cramp-like bearing down pains in lower abdomen. Examination showed tenderness in lower abdomen on both sides. Temperature 103. White blood corpuscles 23,200. Operation left salpingo-oophorectomy glass tube and gauze drainage. Result recovered. Operator Dr B C Hirst.

CASE 35 P D. admitted June 17 1915. History Had miscarriage three months before admission. Five days afterward membranes came away. She then had chills fever and abdominal pain and was taken to another hospital where she was operated on for pelvic cellulitis. On admission she had a tender mass anterior to uterus. Temperature 102. Operation extraperitoneal section abscess opened and drained with gauze. Result recovery. Operator Dr N L Knipe.

CASE 36 H M. admitted October 27 1915. History Delivered three months ago after which she says she was infected, and was operated on in another hospital five weeks ago laceration being closed with drainage. Since has been improved up until one week before admission, when she had pains in abdomen and pelvis, with fever and general malaise. Right tube and ovary removed at previous operation. Tender mass in left side of uterus. Operation left salpingo-oophorectomy appendectomy freeing of adhesions glass tube and gauze drainage. Result recovery. Operator Dr B C Hirst.

CASE 37 G B. admitted April 25 1916. History Ten days after delivery which was normal, had a rapid pulse with tenderness and rigidity in lower left abdomen. Examination shows a mass in left broad ligament. Operation drainage of abscess in uterus and broad ligament glass tube and gauze. Result recovery. Operator Dr N L Knipe.

# DEPARTMENT OF TECHNIQUE

## NON-OPERATIVE TREATMENT OF GUNSHOT FRACTURES OF THE FEMUR

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GUNSHOT fractures of the femur are nearly always infected. Less than one per cent of our cases have healed *per primam*. Rydiger in the *Wiener klinische Wochenschrift* May 11, 1916 reviewed 138 cases all of which were infected. Many other Austrian surgeons have made similar reports.

Gunshot fractures of the femur obviously may vary from a simple partial or complete breach of continuity as from a bullet nearly spent, to extensive shattering fragmentation, as when due to the entrance of an explosive missile. The wounds of the soft parts vary from small sharply defined canals to huge excavations.

Whatever the nature of the wound and whatever the condition of the bone rest is the most important factor in healing. Von Eiselsberg and von Harburg have especially emphasized this point. Perthes goes so far as to advise disregarding the position of the bone fragments in putting the leg at rest until the infection has subsided. However it may be said to be the general belief that as a rule rest can be secured and the bone fragments held in good relative position at the same time. There is moreover general agreement with Schmieden in his view that at the front femur fractures should merely be put to rest and that all efforts to secure extension, however simple such efforts might be, should be delayed until the patient has reached a hospital in which he can remain for several weeks at least.

Methods of securing rest at the front resolve themselves into the use of plaster-of-Paris or starch casts and splints. The proper valuation of the plaster cast has been a subject of much discussion in Austria. The defenders of the cast contend that it immobilizes better than any other device that a patient in a cast is easily transportable that windows in a cast allow easy access

to wounds that the plaster itself can be conveniently shipped to the front and that even at the front extension may be secured easily and safely by the use of a well fitting cast. The opponents of the cast on the other hand maintain that plaster is not easily employed at the front and that if improperly applied it does far more harm than good. In femur fractures, for example if the cast does not include the trunk, thus fixing the hip and does not include the foot to prevent rotation, it is worse than useless.

To apply such a cast requires considerable time and art. Then too a patient in a cast should always be kept under observation for several days to make sure that pressure necrosis will not occur. Owing to the swelling caused by the infection it is very difficult at times to prevent interference with the circulation. In addition it is averred with good reason that casts often hide pathologic conditions such as gas infections and abscesses since only that part of the leg can be observed which is under the window.

As a result of a rather extensive observation of various methods we are of the opinion that the plaster cast is of value in the base hospital only and even there in selected cases only. When the infection has practically subsided or reached a chronic stage with the fragments in good position a well applied cast with a large window or defect bridged by a bent iron brace is certainly of value in providing rest and in some cases in providing extension as well.

There are innumerable and widely varying splints in use on the Austrian fronts very few of which have any value in securing extension but all aiming at the three chief desiderata, namely immobilization of the part, accessibility of the wound and comfortable safe transportation.

For first aid, a splint made of two blanket rolls on one or two pillows bracing the thigh at the

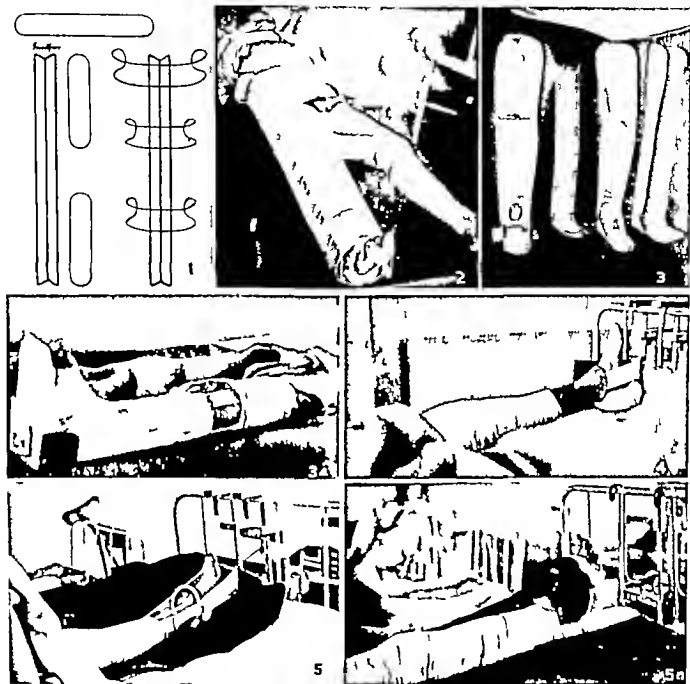


Fig. 1 Universal splint (left) Same used as von Eiselsberg splint (right) (Fengemann, *Wien klin Wchensh* No. 6, 9, 6)

Fig. 2 Pantaloons splint fixing trunk and opposite thigh.  
Fig. 3 Tin and cardboard boots and wire splint of Kramer

Fig. 3a Cardboard boot with starch bandage shown in application

Fig. 4 Tricot and mastic extension.

Fig. 5 Mastic extension with iron ring to prevent decubitus.

Fig. 5a Shoe top extension

back and sides answers fairly well in an emergency. The so-called universal wire splint<sup>1</sup> is ingenious and useful (Fig. 1). It is briefly a long ellipse from 55 to 75 centimeters in length and about 12 centimeters in width made of soft malleable iron wire 12 millimeters in diameter

This is fitted along the posterior lateral aspects of the lower extremity and held in place by bandages the wounds of course being left exposed. Von Eiselsberg has used and recommended a somewhat similar wire splint. The wire splint of von Eiselsberg fixes the foot to prevent rotation and maintains a constant position of the



Fig. 6. A. Box extension by ice tong. B. Schmeer lamp. C. Hey Groves English splint.

Fig. 7. Tension by ice tong.

Fig. 8. Tension by Steinman pin.

Fig. 9. Schmeer lamp and Hey Groves English splint.

Fig. 10. Tension by Steinman pin.

thigh with relation to the trunk. P. Moehring describes a wire splint similar to that of Engelmann.

The so-called pantalon splint (Fig. 3) seeks to fix the hip not only by including the trunk in its grasp but also by using the sound thigh as a brace. The tin boots of P. Put and Volkmann (Fig. 3) are light and easily constructed.

Heavy card board boot splints are popular on the Austrian fronts if we may judge by the number of patients wearing them who come in the transports to Reserve Hospital No. 8. The card board is so cut as to leave a foot sole prolongation at the lower end which is bent forward to support the foot. At the sides the boot is shaped by making superficial longitudinal slits which permit bending without breaking of the card board (Fig. 3). A discussion of the card board splint by S. Springer appeared in the *Wiener klinische Wochenschrift* No. 40, 1916.

The Kramer woven wire splint because of its lightness, cheapness and universal applicability is used in many field hospitals. It consists of two soft iron wires of any desirable length held parallel to each other at a width distance of

Wesschen and Wesschen, p. 1.

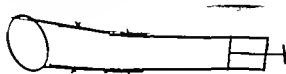


Fig. 11. Metal jointed splint of a thigh.

about 15 centimeters by a thin interlacing wire tied. The wire is so woven as to run from one lateral support to the other not at right angles direct but in a curving direction so that the splint may be fitted readily to the varying dimensions of the extremity (Fig. 3).

In the majority of cases the application of a splint may with safety be accompanied or followed by an attempt to secure a good position of the bone fragments. In gunshot fractures that is to say in infected fractures all violent attempts at reduction as Perthes has admonished should be avoided until subsidence of the infection has made them harmless. Nevertheless wherever it is possible to do so by gentle manipulation and cautious traction the bone fragments even in badly infected fractures should be brought into the best position possible under the unfavorable condition. The wound treatment need not be suspended except in the rarest instances during treatment by extension and counter extension.

There is little or no conflict of opinion as to the propriety of beginning extension in most cases as soon as the patient reaches the base hospital where he can remain until well. In a comparatively small proportion of cases acute swelling and other phenomena of active infection will forbid this, but as a rule after roentgen examination and removal of bullets, metal fragments or bits of cloth some form of extension may be used while hot wet dressings, continuous irrigation or other means are employed to combat the infection.

The familiar Buck's extension so long in popular favor in the United States, we have not used



Fig. 1 Showing jointed splint applied with shoe top extension.

Fig. 12 Jointed splint with knee flexed.

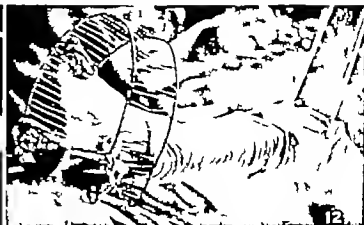


Fig. 3 Continuous rinsing of superficial wound

Fig. 4 Continuous through-and-through irrigation with leg splint.

for two important reasons. First adhesive plaster is extremely scarce in Germany and Austria and second the lacerated wounds common in gunshot fractures make the application of a Buck's extension difficult or impossible in many instances. In lieu of adhesive tape we have employed in suitable cases strips of Canton flannel applied as the adhesive plaster is applied in Buck's method and held in place with the glue known as mastesol consisting of powdered resin 50 grams alcohol 50 grams benzine 25 grams Venice turpentine 5 grams. The mastesol is spread over the rough side of the Canton flannel and applied over the skin surface as well. A spiral reverse gauze bandage holds the flannel strips smoothly and firmly against the varying diameters of the extremity. Mastesol thus applied will resist an extension weight of ten or fifteen kilos for several weeks. A firmly woven stocking or a leg of tricot underwear may be used to replace the strips of flannel. The tricot makes a serviceable and elegant extension device

(Fig. 4). When flannel strips or tricot stockinet and mastesol are used excoriation or decubitus of the malleoli may be prevented and an equal pull all around be obtained by incorporating an iron ring in the flannel strips or tricot just above the ankle (Fig. 5).

The flannel strips or stockinet glued with mastesol should obviously extend no higher than the upper end of the lower fragment. However if at all possible they should extend above the knee-joint in femur fractures. The leg with the mastesol extension may lie upon a pillow or rest in a suitable splint for example the English cradle splint of Hey Groves shown in several of the accompanying illustrations. At any rate the splint must be so made that the wounds are at all time exposed. Perhaps before the surgical society of the middle Rhine spoke for everyone with experience in treating gunshot thigh fractures when he said that all extensions must be so applied that the bandages can be changed without moving the limb. Dressings over the wounds





Fig. 5 (top). Cardboard and gauze window for open treatment.

Fig. 6. Bridged splint for open treatment.

Fig. 7. Kraske splint used as bridge for open treatment.

should be discarded wherever possible in favor of open treatment but if dressings are used they need not be held by bandages encircling the limb but with the idea of convenience in changing them can be simply pinned or tied to the splint.

Mastesol extension has two disadvantages. The skin in some cases will not withstand the desired pull without laceration and not rarely the glue produces dermatitis. In Reserve Hospital No. 8 there have been very few cases of mastesol dermatitis, but many instances of annoying mastesol eczema are reported in the literature of war fractures. If the mastesol is not well borne extension may be secured by using a large sized shoe upper well padded as shown in Figure 5a.

In femur fractures associated with large infected wound of the soft parts requiring constant irrigation or wet dressings the cradle splint of

Hev Groves of Bristol or some device very similar to it is almost indispensable.

The radle splint is a skeleton double incline made of heavy wire and admits of easy access to every part of the lower extremity from the foot to the hip. The splint is prepared for use by slinging double strips of flannel or rubber bandage across from side to side. The rubber bandage is employed at any spot adjacent to a profusely discharging wound or when much irrigation is to be used.

The cradle splint not only permits access to the wounds wherever they may be but also permits the retention of the extremity in the most favorable position namely with the knee slightly flexed so that by the use of the Steinmann pin, the Schmersz clamp, the Hev Grove horseshoe screw clamp or an ordinary ice tong traction may be secured in the line of the long axis of the femur and applied directly to the bone itself (Fig. 6).

In femur fractures with great laceration of the soft parts or in fractures received later treatment after the callus has become rather firm with the fragments in faulty relation direct traction as provided by the ice tong method or the Schmersz clamp presents distinct advantages. With the Steinmann pin it has been possible to overcome partial union and the contracture of muscles in many instances in which weeks and even several months has elapsed after the injury. The strongest or most powerful extension is obtainable with the Steinmann pin (Fig. 7a) moreover the Steinmann pin or one of its modifications can often be used where the extensive destruction of the soft tissues would exclude every other method. Our experience with the pin transfixing the femur at the condyles and transfixing the os calcaneum are similar to those of Finstere and Rana who reported their experience at the meeting of the Vienna Military Surgeons November 21, 1916. We have found that the pin does not cause pain after the first few days, if properly applied. If the skin is retracted upward during introduction of the pin there will be no discomfort due to traction on the skin.

If aseptic precautions be taken there need be no danger of infection. The pin enables the surgeon to apply an extension of 30 or 40 pounds and by pulling directly on the lower fragment of the bone itself it has the most direct effect possible in securing and maintaining good alignment and coaptation.

We have used the Schmersz clamp in femur fractures with even greater satisfaction. Where

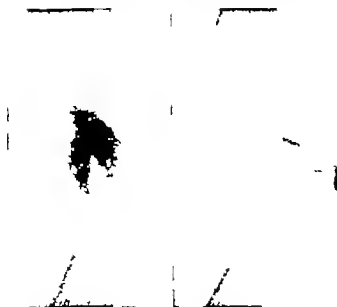


Fig. 18 Type of badly comminuted gunshot fracture successfully treated by irrigation and extension.

as the Steinmann pin is perhaps best introduced under general anesthesia the Schmerz clamp can be applied under local anesthesia in practically every instance. The clamp may be applied to the condyles of the femur to the tuberosities of the tibia to the malleoli or to the os calcaneum according to the nature, size and position of the infected wounds of the soft parts (Figs. 8 and 9).

As in the case of the Steinmann pin the use of the Schmerz clamp is not likely to lead to troublesome infection of the small wounds made for the purpose of applying the device. In Reserve Hospital No. 8 the clamp method has been used in cases where there were large profusely suppurating wounds less than 5 centimeters from the clamp and it was borne without pain or infection of the clamp wounds. Ranzi and Finsterre reported many cases in which the extension clamp was used on patients lying in continuous baths the bath water being laden with infectious matter and yet there was no infection of the clamp wounds.

As above stated pain and necrosis due to traction on the skin by the Steinmann pin or Schmerz clamp may be avoided by retracting the skin upward during application of either of these instruments. No holes should be cut in the soft parts in introducing the pin. The pin itself should be bored (not driven) through the skin and the soft tissues overlying the bone through the bone itself and out through the skin on the opposite side to insure a snug fit and a snug fit is the best insurance against pain and against infection as well. If the bone be drilled or bored

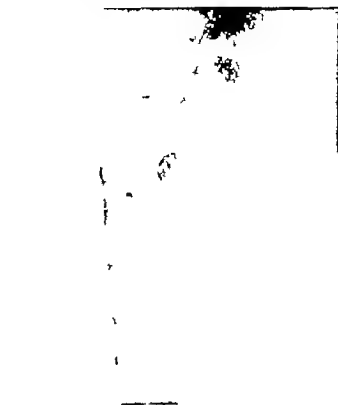


Fig. 9 Femur fracture with lodged bullet treated by extension. Complete healing with 3 cm. shortening.

by another instrument than the pin itself there will be more danger of pain due to looseness of the pin than if the pin makes its own canal.

The position of choice in applying the pin or clamp in femur fractures is the femoral condyle. Where this is impossible owing to the nature of the wound the tibia at a level about 5 centimeters below the knee joint may be selected. The sinuses resulting from the use of the clamp or pin heal promptly as a rule and there have been in our cases no evidences of late infection in the form of bone necrosis or abscess. If the pin is bored through it will as Hey Groves says fill its own bed and later if absorption of bone occurs the defect is filled by granulation tissue which also fills the whole track when the pin is removed. The danger of infection spreading widely in the soft tissues with resulting phlegmon or abscess is practically obviated by omitting the scalpel wounds unnecessary for insertion of the pin.

In cases of femur fractures with great overriding deformity and consequent shortening arriving at the hospital after some hardening of the callus has occurred excellent results have been obtained by the use of a modification of the Thomas metal extension splint. The metal splint shown in Figure 10 overcomes two of the



Fig. 20. Femur fracture treated by Steinmann pin shortening.

chief objection to the Thomas splint. In the latter the padded ring and perineal post at the proximal end are fixed and may not fit well unless each patient is measured for his own splint. In the modified metal splint the padded ring may be adjusted both at the perineal post and at the outer lateral bar and thus made to conform to the varying dimensions of the hip region. The mobility of the ring upon the posts is of noteworthy value in preventing pain and soreness. In the Thomas splint the knee must be kept straight and can be given no passive movements until firm union has occurred whereas in the metal splint having its own knee joint hinge stiffness prolonged perhaps into many months need not occur because of lack of exercise to the knee joint (Fig. 12). Unlike the Hey Groves, Hodgen and Balkan splints the metal splint shown in the illustration does not tie the patient to his bed but allows of comparatively comfortable transfer from bed to bed or to the roentgen room.

In dealing with foreign bodies associated with fracture it has seemed wise to remove them early. It is of course true that a small percentage of metal fragments will heal in aseptically and do no harm; however we have preferred to look upon all foreign bodies as favorable to early or late infection processes and have taken them out operating under roentgen. Judging from personal observation of nearly 2 thousand cases of gunshot fractures very few of which have been entirely free from infection it may not seem unfair to say that it is erroneous to think of the foreign body in gunshot fracture as uninfected.

As stated above the infection has been treated by the application of hot wet dressings or continuous irrigations (Fig. 13) in either case using Dakin's solution. The wounds have been left open and exposed to sunlight wherever possible.

Almost all badly infected cases were placed in the English cradle splint of Hey Groves and given more or less extension from the beginning. Where drainage was necessary rubber tubing was used. An irrigating can was placed over the bed and the wound continuously drenched with the sodium hypochlorite solution of Dakin. Wherever indicated the tube was passed entirely through the thigh for through and through irrigation (Fig. 14). Bandages and gauze packs and dressings were discarded in so far as it was possible to minimize foreign body reaction. The patients like the open irrigation plan of treating the infection with its absence of stiff adhering dressings and painful change of bandages.

In very bad cases with huge lacerations of the soft tissues and comminuted, almost pulverized bone the whole discharging enormous quantities of pus, we have observed complete cleaning up of the wound within six weeks and with the bone fragments in good position extension having been carried out during the irrigation of the infected wound. As a deodorant the old plan of using coarse granulated sugar may be tried with confidence. E. Meyer and T. Hercher state that the virtue of the sugar lies in its stimulation of lymph flow. Von Herft advises the addition salicylic acid.

Marshall and Weinacker. G. N. 9.

## OBSERVATIONS IN MILITARY SURGERY

BY WILLIAM ARTHUR CLARK, M. D. CHICAGO

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THE wounds encountered in the present war vary according to the type of projectile inflicting them but although it is easy to tell no extensive shell wound from a simple bullet wound it is sometimes difficult or impossible to tell the type of projectile by the nature of the wound. A small penetrating wound may be made by a rifle ball, by a shrapnel ball or by a small fragment of shrapnel or shell. Badly lacerated wounds are usually due to shrapnel or shell but may be produced also by exploding bullets, expanding bullets or by a plain bullet striking a bone.

An expanding bullet is an exceedingly destructive projectile. It consists of a soft lead body with a heavy hard steel core and a nickel-copper jacket (Fig. 1). When the bullet strikes its steel core is forced by its own momentum through the soft lead causing the lead to expand with a sudden force which bursts the jacket and sends its fragments through the tissues. These pieces of the jacket have been found in the chest after the bullet has struck and mutilated the head. The exploding bullet (Fig. 2) is also destructive but works on a different principle. At its tip inside its jacket is a pocket of high explosive behind which is a fulminating cap and a sharp steel pin buried in the soft lead body of the bullet. When this bullet strikes the momentum of the steel pin forces it against the cap which in turn ignites the explosive. The fragments of the bullet are thus scattered through the tissues causing extensive laceration. The dum-dum bullet first made at Dum-dum, India is a plain lead body covered with a nickel-copper jacket all except the tip. When it strikes the lead expands through the uncovered tip.

These three types of bullets are of course not in wide use as they are prohibited by resolutions of the Hague Peace Conference but cases of injury from them have been seen in several instances.

Shrapnel balls are not efficient as destroyers of life. They have but little penetrating power and are rarely found deep in the tissues. The more deadly shell is displacing the shrapnel. The following table shows the relative number of wounds from the different sources under treatment in the Ambulance de l'Océan at La Panne for the months named in 1916.

	Bullet	Shrapnel	Shell	Accident
July	449	39	266	85
August	455	20	483	67
September	376	18	484	78

The mortality during this period and for the twelve or fifteen months preceding was 10.5 per cent. Early in the war the mortality at the same hospital was about 20 per cent. This reduction is due to better organization and equipment, routine antitetanic prophylaxis, compulsory baths for the soldiers, improvement in the technique of amputations and standardization of the treatment of infected wounds. These mortality figures it should be stated are from a first line hospital six miles from the firing line. The low percentages of four or even two sometimes seen quoted are from base hospitals fifty to a hundred miles back.

## SKULL WOUNDS

In spite of the steel helmets wounds of the skull are frequent. After deep penetrating wounds and through-and-through bullet wounds brain hernia has been common and the resulting mortality high. The surgeon is between the two evils of immediate meningitis if he closes the wound and cerebral hernia if he leaves it open. At La Panne a compromise technique has been employed consisting in packing tightly with gauze and suturing the skin over all. This packing is removed at each dressing, the wound irrigated and repacked and the skin sutured over again but even under these precautions the brain substance usually protrudes and after three to six weeks the inevitable sepsis results in meningitis and death. In some French hospitals the practice of suturing the dura, after the removal of all loose bone fragments and other debris, has been adopted with the result that the mortality in these cases has been appreciably reduced. Velter (1) reports a mortality of 14.7 per cent in 61 cases operated upon. He attributes the infrequency of encephalocèles in his service to suture of the dura and regards systematic radical intervention as the essential factor of success. The inner table is always fractured more extensively than the outer and it is necessary to trephine and cut away the bone up to the sound tissue and beyond the lacerations of the dura. In 25 of the 61 cases he obtained good results.

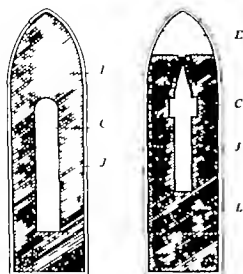


Fig. 1

Fig. 2

Fig. 1 Section of expanding bullet. L Lead body  
C Steel core J Jacket upper jacket. Enlarged  
Fig. 2 Section of expanding bullet. L Lead body  
C Steel core J Jacket upper jacket. L Lead body  
Enlarged

without drainage. The others were drained with strands of horsehair. The following case is typical of many which came under the writer's observation.

C. The patient suffered bullet wound of the skull with fracture in the posterior parietal region on the right. The photograph (Fig. 3) as taken four weeks after entrance. The portion of the right hemisphere which protruded through the wound could not be reduced and dissection began to form which had to be broken up each daily dressing. The temperature fluctuated between normal and 40° C. No pockets of pus could be found on exploration. At top of neck after entrance generalized meningitis was found.

#### FACE AND JAW WOUNDS

Lacerations of the face with fracture and loss of substance around the nose, mouth and jaws constitute some of the most difficult problems. A method of dental alignment and fixation in cases of fracture of the jaw devised by Dr. Rubbrecht (2) a Belgian oral surgeon deserves special mention. A metal band is placed around one sound tooth on each side of the fracture. On each band is a hook to which can be attached a heavy silver wire. When the fracture is properly reduced and the alignment of the teeth is good the wire can be quickly and easily fastened to the hooks thus holding the fragments securely in the exact position in which they are placed. The study of the proper direction of force necessary to hold the fragments in correct position is first



Fig. 3. Encephalocoele from bullet wound. Death from meningitis.

made then the metal bands are made over a plaster cast of the teeth and finally fitted on the real teeth. This method differs from and excels other methods in that the apparatus is applied before the reduction and all that remain to be done after the reduction is the final clamping of the silver wire on the hooks which is done instantly while the parts are held in alignment.

The restoration of the soft parts is dependent on the amount of tissue remaining with which to work. If the lips are not destroyed the patient is practically assured of a fairly good mouth but if as in many cases, the entire lower lip and jaw are gone and the upper lip badly lacerated all the skill of the plastic surgeon is ails only to make a misshapen orifice opening more or less downward which in many cases cannot be closed and from which the saliva flows uncontrolled. Figures 6 and 7 show one of the more fortunate of these *blessés* before and after plastic repair.

#### LOCALIZATION

In recent years the practice and teaching in civil surgery regarding imbedded bullets has been conservatism. This teaching is overthrown by the French in their enthusiasm for the removal of all foreign bodies. Ways and means in great variety have been ingeniously devised for localizing the minutest fragment of shell as well as shrapnel and rifle bullets. The vibrator of



Fig 4 Encephalocoele. Recovery



Fig 5 End result of case shown in Fig 4

Professor Bergonié (3) serves for locating all metal bodies except plain lead which are lodged in the soft parts. The large electromagnet (Fig 8) is attached to a wall bracket and when used is swung out over the operating table. An interrupted current sent through it causes a vibration of the foreign body which can be felt by the surgeon either through the skin if sufficiently superficial or by inserting the finger into the wound or incision if the foreign body is deep. Obviously if the fragment or bullet is securely lodged in the bone or if it is of unresponsive metal such as a plain lead shrapnel ball it will not be revealed by the vibrator. However it serves in the great majority of cases because all rifle bullets have nickel-copper jackets which enable them to vibrate under the current and almost all shell and shrapnel fragments are steel.

The telephone probe is an interesting but rather impracticable instrument since the foreign body must first be found and the probe placed very near it before the ear can detect the sound. A modification of this system in which a tip containing the finding electrode or probe is placed over the finger and a rubber glove put on as usual over all is more satisfactory, since the finger searching in the wound has the aid of the ear in determining the proximity of the foreign body.

The roentgen-ray has had added to it many auxiliary devices for giving accurate localization of bullets and shell fragments even of the smallest

size. The most scientific and precise of these is the Hertz (4) compass localizer. This is a three legged instrument with a central adjustable pointer which is used in connection with the roentgen plate. Two exposures are made on the same plate the tube being moved a definite distance between exposures giving two shadows of the foreign body as well as of the three metal markers placed on the skin. The distance between these two shadows varies of course with the distance of the object from the plate and in a certain ratio. The distance of one of the metal markers from the plate being a known quantity, the unknown quantity or distance of the foreign body from the plate can be determined by comparing the distance between the two shadows cast by the marker and the two cast by the foreign body. This calculation is made and the determined distance is set on the adjustable pointer of the instrument. After transcribing the shadows of the plate to a chart and reducing the double shadows to single shadows by trigonometrical plotting as shown in Figure 9 the instrument is adjusted over the chart its pointer on the actual position of the foreign body and its three adjustable legs on the actual positions respectively of the three markers. Clamped in this position the instrument is transferred to the field of operation where its three legs are placed on the three respective marked positions on the skin where the metal markers were when the plate



Fig 6 Shrapnel wound face

was taken. The pointer will then indicate not only the position but the depth of the foreign body.

The success of this method depends almost entirely upon the work of the roentgenologist. The surgeon is saved the annoying search by following the direction of the pointer and the *Besse* is saved the extensive incision and trauma which goes with a haphazard method. In the limited experience of the writer the accuracy of this instrument has seemed in some instances actually uncanny.

Many other forms of apparatus such as the ladder scale used and described by Shaxby (5) a similar method reported by Mazérès (6) a belt arrangement by Mienet (7) with none of which the writer has had experience all testify to the enthusiasm with which the search for the hidden projectile is carried on. It should be mentioned that in a few instances undoubted detriment to the *Besse* results from an overzealous hunt for the foreign body and it would seem that the personal element plays a large part in success or failure of any of the methods. For example two cases are recalled which are at the opposite extremes. A *Besse* had a bullet removed from the lung in less than five minutes with the aid of the Hirtz localizer. Another *Besse* had a bullet in the buttock which was not found in two operations, the wound being enlarged from the small puncture of entrance to a large gaping crucial incision with suppuration which finally opened through at the inguinal region the *Besse* meanwhile becoming markedly weakened and emaciated.



Fig Result of case shown in Fig 6. The patient is to have no more plastic operation.

#### WOUND INFECTIONS

In the civil practice of modern surgery asepsis has been the slogan. Obviously in war surgery the observance of asepsis is precluded because all the wounds are potentially septic. Antisepsis then, has again been forced to the front in the technique of the present war to combat the virulent infections which exist in most of the cases. A small percentage of the wounds do not suppurate and these are as a rule the through-and-through bullet wounds of muscles. The bullet itself is of course aseptic from the heat generated by friction with the air and it may be supposed that its heat is sufficient to sterilize the clothing and skin which it touches in passing. Furthermore the amount of lymph and bactericidal agencies poured into the small path of the bullet is relatively greater than the amount accessible in the larger ragged wounds, and the chance for secondary infection is small. At any rate such wounds practically never suppurate unless in a fatty part and may be treated only by trimming away the blackened edges at the wounds of entrance and exit and applying iodine and a sterile bandage.

The deep and extensive lacerations hitherto rarely encountered furnish new problems in treatment which were met by researchers of several British and French medical officers. The







Fig. Fracture of both bones just below knee. The leg lies in hammock rising from the movable part of the cradle. Extension by adjustable splint. The rubber tube connects with can of Dakin's solution.

previous paper (13) these details will not be entered into here, but attention may be called to some sources of error and to the indications for discontinuing the treatment.

The method has been spoken of as a continuous irrigation with Dakin's solution, but it is better to call it an installation for the solution is allowed to enter the wound very slowly—about thirty cubic centimeters per hour for each tube—and there is never any overflow beyond what is taken up by the copious dressings. It is only necessary to have a water proof covering for the bed. The Carrel tube is of course not a drainage tube but an installation tube. It must extend to the depth of the wound for the success of the method depends upon the solution bathing every square inch of traumatized tissue. The proper length

must be chosen so that the perforated gauze or cloth portion will not protrude out of the wound, otherwise most of the solution as it moves down from the reservoir will be soaked up in the dressings and never reach the depths of the wound.

If the wound is already discharging much pus, large drainage tubes must be used to facilitate the discharge for as stated above one does not depend upon the Carrel tube for drainage. Dermatitis around the wound means that the solution is alkaline and must be changed. Vaseline or other fatty ointments do no good as they saponify with the sodium solution.

Although clinical signs can furnish indications for closure of the wound when we have had sufficient experience to read them correctly one must at present rely upon bacteriological examination of the fluid from the wound for such indication. Depage (14) states that two or three negative examinations should be obtained before the wound should be considered free from bacteria and ready for closure. The count of organisms is begun on the second day and continued as necessary until negative results are obtained. Many cases are reported in which under the Carrel treatment the wound can be sutured in four or five days, but the average time is much longer. In 13 cases sutured after this method and reported by Depage there were 112 complete successes, 23 partial successes and two failures.

#### FRACTURES

The type of fracture encountered in military surgery is a distinct one and is not accurately described by any term in use in civil practice. For want of a better name the writer suggests shattered fracture. Thus shattering of the bone whether it be one of the long bones or a flat one results from an explosive effect of the projectile. The fragments are usually numerous and vary in size from tooth pick splinters to total sections of the bone.

In the primary treatment of these shattered fractures, the question of removal of the fragments immediately arises. Shall the surgeon adopt the radical plan of removing all loose pieces—total *exskeletonation* as the French call it—or shall he seek to conserve all the bone? If he adheres to the total removal plan he is confronted with a gap between fragments of from one to six inches, across which a natural callus cannot form and with a flail leg or arm or a pseudarthrosis any of which will require subsequent operation and bone grafting with doubtful results. If the conservative plan is

adopted the *blesse* will have a longer convalescence and run greater risk of infection and amputation. The radical method gives quicker control of sepsis and a shorter convalescence enabling the *blesse* to be evacuated earlier than otherwise.

In modern military surgery it seems that the methods of the conservative surgeon have no place. This is more noticeable in the treatment of shattered fractures than anywhere else. The French have adopted the radical treatment by total *esquilectomie* almost universally. Their results have been good as far as conservation of the limb and of life is concerned but most of the case reports on account of the exigencies of military surgery with rapid evacuation of *blesse*s do not give the later history regarding the ultimate success or failure of the method that is whether union occurred or not and what subsequent treatment operative or otherwise was necessary. Eynard (15) reports 124 cases of shattered fracture of various bones in which total *esquilectomie* was done but only six were followed long enough to permit of observation regarding union and in only one of these six it is stated that union occurred. He states that it is better to remove a little periosteum than to leave a single denuded fragment in the wound and that for one piece which will live there are a hundred which will die and form sequestra. His mortality in these cases was 1.6 per cent and amputations 8.8 per cent. Cotte (16) regards primary subperiosteal *esquilectomie* as the only method of preventing or curing infected open fractures and saving the limb. His reported cases include 41 humerus, 28 forearm, 57 femur and 46 leg, 172 in all. In 108 of these primary *esquilectomie* was done without any amputations and with a mortality of 9.2 per cent. Union is reported in fourteen of the 108 the others were evidently not followed. Jones (17) believes the removal of all loose bone is a common source of non union and suggests that fragments be put back after being removed and washed. Cheever (18) of the American contingent concludes from his experience that fragments if large and attached to periosteum should not be removed but that fragments of doubtful viability always have to be removed.

The writer's experience with these shattered fractures lead to his adoption of the more radical technique. In common with most of the American surgeons entering into the work of the war zone he was at first inclined toward conservatism but soon discovered that more thorough intervention was necessary in most cases to save the limb and sometimes the life. The extreme

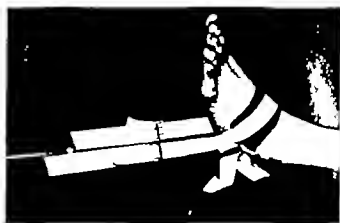


Fig. 11. Detail of extension apparatus shown in Fig. 10.

however of leaving a gap of four or five inches without a vestige of bone is condemned as unfair in the *blesse*. In rifle-ball fractures in which the shattering of the bone is not attended by extensive wounds of the soft parts it is first of all necessary to open wide on both sides even if there be no wound of exit granting of course that the roentgenogram shows more than a simple fracture. The wound should not be irrigated at the primary operation but all debris of clothing and dirt, all blackened tissue and the bullet should be removed. Sufficient bone should be removed to permit the introduction of two Carrel tubes, one from each side. Continuous instillation of Dakin's solution is then begun the limb being fixed on a metal splint. At subsequent dressings the wound being large enough more bone can be removed as occasion demands without anesthetic, conserving the large pieces and with the ultimate result of union constantly in mind. Should pus form rubber drainage tubes of large caliber must be inserted and the entire wound irrigated at each dressing with hydrogen peroxide as a prophylaxis against the gas bacillus as well as for mechanical cleansing.

Extensive shell wound of the upper thigh with badly shattered femur is sufficient indication for primary amputation. The fatalities from secondary hemorrhage and gas gangrene are so numerous as adequately to justify this procedure.

CASE 2. Brocardier, French, 38. Wounded at Neuport March 5, 1916. The patient suffered a shattered fracture at a bi-trochanteric portion of right femur by a shell fragment the wound entrance being at the line anterior aspect and the larger wound exit at the posterior outer aspect of the thigh. The wound was cleaned but no bone was removed. Three Carrel tubes were inserted. Intravenous injection of salt solution and camphor was given. Extension was applied to the leg and instillation of Dakin's solution started.



Fig. 10. Tension applied to soft parts to prevent their retraction after amputation.

March 6 Secondary hemorrhage. Pulse 30 temperature 39. The blood was then washed and search made for the source of hemorrhage. Three or four small cuts were tied off. March 5 Another secondary hemorrhage. Pulse 30 temperature 38.4. A source found but several more small cuts were tied off and salt water injected into the medullary canal. March 10 Pulse small. All day very quiet. Stimulation with trychnine and camphor. March 17 Collapse and death on the dressing table.

Time should be given for recovery from shock before amputation is done and the operation should be rapidly performed according to the method described below. Fractures of the femur are among the gravest of wounds in war surgery because of the difficulties in immobilization and consequent secondary hemorrhage, the inevitable infection often by gas bacilli, persistent osteomyelitis, delayed union, vicious callus, and pseudarthrosis. Casts are not adaptable because of the necessity of frequent dressings and irrigations. The metal splint is the best apparatus, not only for femur but for all shattered fractures. These have been devised in great variety; the number of different kinds only being limited by the number of surgeons in charge of the various services, but there are some points in common which are found by all to be indispensable. The splint must immobilize but permit movements of the patient's body without disturbing the fragments; it must also permit easy access to the wound for dressing and irrigation without movement of the limb. To accomplish this in case of the thigh and leg suspension either overhead or by cradles is necessary in most cases. For the femur except fractures at the neck or trochanter a simple Thomas knee splint with traction from

its lower end to affect a so-called progressive reduction and perineal counter pressure as recommended by Jones (17) is an efficient apparatus. It should have the addition of overhead suspension to allow movements of the patient's body. In case the fracture is at or above the trochanter abduction must be maintained. There is no necessity for a winding bandage in dressing these cases; instead the gauze dressings are held in place underneath by a sectional canvas trough (10) any section of which can be unstrapped separately without disturbing the position of the limb. For the continuous instillation cases these canvas sections should be covered with oiled muslin. The gauze dressings are held above and laterally by canvas buckle straps over splint and all.

Leg and foot fractures are best supported by a hammock hung from the movable part of a cradle (Fig. 10). A sling around the ball of the foot prevents toe drop. If the fracture is lower than the upper third of the leg the usual adhesive strapping for traction cannot be used; instead a padded adjustable canvas halter is buckled around the foot so that the pull comes mostly on the heel and partly on the dorsum. With a little practice this buckle strap apparatus (Fig. 11) can be adjusted to a nicety to prevent toe drop as well as to furnish even traction on the fractured leg.

Fractures at the head and upper third of the humerus are always best put up in extreme abduction, the arm held straight out from the shoulder. This is accomplished by means of a so-called aeroplane splint which consists of a table portion strapped to the chest and an

adjustable wing supported by rods from the fixed part upon which rests the arm and forearm. The advantage of this abducted position is that the pull of the shoulder muscles especially the deltoid is precluded by their being relaxed. In case of complete destruction of the head and glenoid surface this position is the most favorable one for ankylosis which is about the only result to be expected because when the ankylosed arm is let down again the scapular muscles will then have some power over the arm which they would not have if the ankylosis were allowed to occur in the hanging adducted position.

#### AMPUTATIONS

Very early in the progress of the war it was found that the shaping of a classical flap in doing a primary amputation was a waste of time and tissue. The infection which invariably followed resulted in sloughing of the flaps which demanded a secondary operation and in some cases a reamputation. It was found more expedient to perform a rapid amputation of all tissues skin muscle and bone at the same level what the French call *coup de hache*. Aside from ligation of vessels nothing is done but the straight-across cut severing the part as it might be done by laying it on a block and clipping it off with a headsman's axe. In the wide-open wound thus formed the infection can be easily controlled and cleared up. In the meantime the soft parts of course have a tendency to contract away from the bone and in the thigh cases this is sometimes serious as the surgeon seeks to conserve as much tissue as possible. To overcome this contraction it is necessary to apply wide adhesive straps at four points around the stump and attach a weight of from five to ten pounds which will hang over a pulley at the foot of the bed and maintain a constant traction against this retraction of the skin and muscle (Fig. 12).

When the granulations begin to form and the pus is all gone the plastic repair of the stump is done including reamputation of the bone and of the nerves and the shaping and suture of the flaps.

At the Ambulance de l'Océan at La Panne before the adoption of the *coup de hache* technique the mortality from amputations of the thigh was 60 per cent. After this technique was introduced the mortality fell to 30 per cent. This reduction it must be admitted was not due entirely to the technique as there has been a general decrease from the rather high mortality percentages of the early part of the war but this is one of the important factors which have brought about the decrease.



Fig. 13 Bath house near the Belgian first line. Pipe for intake is upstream and discharge pipe (not shown) is down stream.

#### GAS GANGRENE

Another factor which has contributed to the decrease in mortality is the prevention and better control of gas gangrene. The organism of this infection has been found in the soft fertilized highly-cultivated soil of Flanders and northern France. In the beginning before the medical services were prepared and soldiers went for weeks without baths and clean clothes and without proper hygienic care gas infections were numerous and fatal. At present the occurrence of this infection is not so frequent and mortality not so high. The system of compulsory baths in the Belgian army has been one of the most important means of bringing about this decrease. Bath houses are located near every group of barracks or at rest stations. Where possible they are placed on the bank of a stream as shown in Figure 12 from which the water is obtained for the ablutions. An intake pipe is placed upstream and an outflow pipe discharges the waste down stream. The cleanliness of the skin of the soldier reduces the chances of all other infection as well as that of the gas bacillus.

When the characteristic fetid odor the fine crepitation of the skin (felt only on light palpation) and the appearance of little bubbles in the wound warn the surgeon of the presence of a gas infection intervention must be immediate and radical. The best agent against this anaerobic organism is oxygen. It should be injected with a long needle connected up by a tube with the oxygen tank first into the good tissues above the wound under the skin and deep into the muscle until the part is blown up to the limit of the patient's endurance. It should then be blown into the infected tissues in the same way. Copious irrigation with hot peroxide is used at

every dressing. The absorption of this infection is so rapid (death sometimes occurs within twelve hours after appearance of the signs) that conservative and expectant treatment are decidedly counter-indicated. If the wound in the thigh amputation is the worst course for the organ ism may reach the abdomen from which there is no recall. When in doubt amputate and amputate high and early.

## CONCLUSIONS

In the great majority of cases conservative surgery has no place in the military practice of the present war.

Foreign bodies are being removed as a routine by aid of new instruments of localization.

There is a tendency to remove all loose bone fragment in shattered fractures but the method lacks the support of statistical or ultimate results.

Important factors in reduction of mortality are Carrel technique in wound infections, guilotine or *expedient* method of amputation, routine use of antitetanic serum, oxygen injection for gas bacillus infections.

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## CORRESPONDENCE

## CONGENITAL RADIO-ULNAR SYNOSTOSIS

To the Editor: I the Junior of SURGERY GYNECOLOGY AND OBSTETRICS there appears article on Congenital Radio-Ulnar Synostosis by W. W. Feidt of Minneapolis. Minnesota. The author calls attention to the rarity of this condition and states further that heretofore no cases have been reported by American surgeons. I in this connection permit me to state that in the early part of 1916 I presented such a case before the Medical Society of the Mt. Sinai Hospital of Cleveland and at that time I called attention to the rarity of the condition saying that only 20 cases had been reported. Since reading Dr. Feidt's article I find that 40 cases had been reported instead. As I did not send a report of my case to any medical journal for publication nat-

urally pertinent reports with first case in America could not be given me except by the members of our hospital medical society.

The patient was Russian boy 8 years old with the left arm affected. The left hand was preacinated and could not be supinated. He had full power in that hand and arm and showed no especial muscular weakness. He could place his hand on the back of his head and butt on his collar. There was a history of

The radius was bowed and also twisted on its long axis and the X-ray findings are identical with those of Dr. Feidt's cases. The X-rays are still at Mt. Sinai Hospital.

J. J. KURLANDER, M.D.  
 Cleveland, Ohio.

# CLINICAL CONGRESS OF SURGEONS OF NORTH AMERICA

*Eighth Annual Session, Chicago, October 22 to 27, 1917*

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## WAR SESSION OF THE CLINICAL CONGRESS OF SURGEONS IN CHICAGO

THE eighth annual session of the Clinical Congress of Surgeons of North America will open in Chicago on Monday, October 22, with a program covering five full days of clinics and demonstrations in the hospitals, medical schools and laboratories, with evening sessions devoted to the reading and discussion of papers.

This will be a war session—with clinical demonstrations and papers picturing various phases of modern military surgery which will include the many notable advances in methods of caring for the sick and wounded as developed in the past three years with a review of the remarkable work accomplished in the reconstruction hospitals of France and England and the new methods employed in the treatment of

fractures, head and chest injuries, wound infections, etc.

The Committee on Arrangements heartily supported by the clinicians of Chicago are keenly interested to make a complete showing of Chicago's clinical facilities in every department of surgery, including gynecology, obstetrics, genito-urinary surgery, orthopedics and surgery of the eye, ear, nose, throat and mouth.

Clinical demonstrations in the hospitals, medical schools and laboratories will occupy the morning and afternoon hours of each day. In addition to the operative clinics in the hospitals the Committee has provided for a series of demonstrations including surgical pathology, roentgenology, border line subjects and others.

and it is expected that this portion of the clinical program will prove of exceeding interest.

A complete program of the clinics and demonstrations is in course of preparation and will be printed and distributed to members who have registered for the Chicago meeting. The real program of the session will be bulletined each afternoon at headquarters and will be elaborate and accurate in detail as to the cases to be operated upon or demonstrated in the several clinics on the succeeding day.

On another page will be found an outline of the program for the evening sessions.

#### SUB-COMMITTEES ON CLINICAL DEMONSTRATIONS

The work of preparing the schedule of clinics and demonstrations is in the hands of the following sub-committees:

General Surgery: Dean Lewis, Chairman; Charles Davison, Vice Chairman; H. R. Chislett, Secretary; E. Wyllys Andrews, Carl Beck, Louis A. Greensfelder, Samuel C. Plummer.

Gynecology and Obstetrics: T. J. Watkins, Chairman; Charles S. Bacon, Vice-Chairman; Gilbert Fitz Patrick, Secretary; Walter S. Barnes, Joseph B. DeLee, N. Sprout Heaney.

Genito-Urinary Surgery: Louis E. Schmidt, Chairman; Herman L. Kretschmer, Secretary; William T. Belfield, French S. Cary.

Orthopedic Surgery: John L. Porter, Chairman; E. W. Ryerson, Secretary; H. B. Thomas.

Oral Surgery: Thomas L. Gillmer, Chairman; H. A. Potts, Secretary; Truman W. Brophy, Frederick B. Moorehead.

Röntgenology and Radiumtherapy: Hollis E. Potter, Chairman; Adolph Hartung, Secretary; Frank E. Simpson.

Military Surgery: Col. Wm. Stephenson, Chairman; D. A. K. Steele, Vice Chairman; Jacob Frank, John A. Hornsby, Wm. H. Wilder.

Surgery of the Eye, Ear, Nose and Throat: E. V. L. Brown, Chairman; Norval H. Pierce, Vice-Chairman; Francis Lane, Secretary; C. Gurnee Fellows, Otis H. MacLay, George E. Shambaugh, Casey A. Wood.

Pathological Demonstrations: Charles E. Kahlke, Chairman; Oscar Eugene Nadeau, Prof. James P. Simonds, Frank Smithies, John W. Nuzum, Emerich Rosenberg.

Surgical Research and Experimental Surgery: Prof. A. J. Carlson, Chairman; Arthur H. Curtis, Vice-Chairman; D. B. Phenister, Secretary; Prof. R. G. Hoskins, Phillip H. Kreuscher, Oscar T. Schultz.

A feature which proved of great interest at the Philadelphia session, the cinematographic ex-

hibitions of surgical operations, will be repeated at this meeting, depicting some of the newer as well as the classic operations as performed by eminent specialists. These will be given each afternoon at 5 o'clock in the Gold Room of the Congress Hotel.

#### LIMITED ATTENDANCE—ADVANCE REGISTRATION

The popularity of these clinical meetings has proved so great that it was found necessary to adopt the plan of limiting the attendance and requiring advance registration. This plan has worked satisfactorily at previous sessions and will be enforced at the Chicago meeting, thereby ensuring accommodations at the clinics for each one who receives a membership card. A survey of the operating amphitheatres, lecture rooms and laboratories in the hospitals and medical schools as to their capacity for accommodating visiting surgeons has been made and the limit of attendance will be based thereon.

The total of registrations received to date indicates that the limit of attendance will be reached in advance of the opening of the session. Immediate registration is therefore necessary to ensure receiving a membership card, for when the limit of attendance has been reached no further registrations can be accepted.

To each member registering in advance a formal receipt for the registration fee has been issued which receipt is exchangeable for a membership card at headquarters at the Congress Hotel when registering upon his arrival. Headquarters will be open on Sunday afternoon, Oct. 21st, for the convenience of all members arriving in the city on that day. The clinical program for Monday will be bulletined at headquarters at the Congress Hotel on Sunday and on the afternoon of each day there will be bulletined at headquarters a complete accurate program of the clinics and demonstrations to be given on the succeeding day. Printed programs will be issued each morning containing the complete clinical program with announcements for the evening sessions, business meetings, etc.

#### GENERAL HEADQUARTERS

Headquarters will be established at the Congress Hotel where the several large public rooms on the first, second and mezzanine floors have been reserved for the use of the Congress during the entire week. The registration and ticket bureau will be located in the St. Francis room on the mezzanine floor adjacent to the Gold room, in which will be held the evening and business sessions, cinematographic exhibits, etc. The

Elizabethan room on the first floor of the Hotel will be utilized as the bulletin room and here will be gathered the numerous exhibits of surgical instruments, hospital apparatus, medical books, etc. The Florentine room on the second floor will be used as military headquarters.

#### SPECIAL TICKETS

Attendance at all clinics and demonstrations will be controlled by means of special tickets, the number of tickets issued for any clinic or demonstration being limited to the capacity of the room in which the clinic or demonstration is to be given. The general rule will be that a member may have two tickets for each day, one for a morning and one for an afternoon clinic. For certain clinics where the accommodations are limited and the demand for tickets is heavy, it will be necessary to establish a rule whereby a member may have only one ticket for such clinic during the week.

The use of special tickets has proven an efficient means of providing for the distribution of members among the several clinics and ensures against overcrowding at any clinic. Special tickets will be issued each morning for the clinics and demonstrations to be held that day, a complete schedule of the day's clinics having been posted on the bulletin board on the afternoon of the preceding day and a printed program distributed in the morning.

#### REGISTRATION FEE

The constitution of the Congress provides that a registration fee shall be required of each member attending an annual meeting, there being no annual dues for members of the Congress. Receipts from registration fees provide the funds with which to meet the expense of preparing for and conducting the annual meetings, so that no financial burden is imposed upon the members of the profession in the city entertaining the Congress.

#### ANTI FEE SPLITTING PLEDGE

A new requirement for membership in the Congress goes into effect at this meeting in accordance with the following resolution adopted

at the Philadelphia meeting and each member upon registering at headquarters will be expected to sign a pledge in accordance therewith:

*Be it resolved:* First, that the Executive Committee of the Clinical Congress of Surgeons of North America is instructed to provide that hereafter the clinics of the Congress shall be open only to those surgeons who in their respective practice and in intent are opposed to the division of fees. Second, that the meaning of the division of fees be interpreted in substance as follows:

I hereby declare that I do not and that I will not engage in the practice of the division of fees under any guise whatever, that I neither collect fees for others referring patients to me, nor permit others to collect fees for me, nor make joint fees with physicians or surgeons referring patients to me for operation or consultation, nor will I knowingly permit any agent or associate of mine to do so.

#### REDUCED RAILWAY FARES

In certain portions of this country and Canada the railways have granted reduced rates on account of the meeting in Chicago. In particular these reduced rates will be in effect in the territory covered by the Central Passenger Association, Trunk Line Association, New England Passenger Association and Eastern Canadian Passenger Association, which includes in a general way the states east of the Mississippi River and north of the Ohio and Potomac rivers except Wisconsin and portions of Illinois. An application for a similar reduction in fares by the lines in the Southeastern states is now pending and we believe will be acted upon favorably. Round trip tickets will be sold at reduced rates going and returning via the same route only and over which one way tickets are regularly sold. Tickets will be sold from points within the territory specified above on October 20, 21 and 22 except that in some points in Eastern Canada tickets will be sold on October 19 with a general return limit to reach one's original starting point on or before midnight, October 31. For full particulars with regard to rates, members are requested to inquire of railway ticket agents in their home towns.



## PROGRAM OF EVENING SESSIONS

*Monday October 22 8 P M Orchestra Hall*

Address by Chairman of Committee on Arrangements	A J OCHSNER, M.D. Chicago
Remarks by retiring President	FRED B LUND, M.D. Boston
Inauguration of President-elect JOHN G. CLARK, M.D. Philadelphia.	
The General Medical Board of the Council of National Defense	FRANK H. MARTIN, M.D. Chicago
Observations upon the Medical Service of the French Army	MAJOR E. RIST
Observations upon the Medical Service of the British Army	SIR BERKELEY MOYNIHAN, Leeds, England
The Work of the American Units in France	GEORGE W. CRILE, M.D. Cleveland, Ohio
The Food Situation—Relation to Our Military Activities	ALONZO TAYLOR, M.D. Philadelphia

*Tuesday October 23 8 P M Gold Room Congress Hotel*

Symposium—Specialization in Military Surgery	
General Surgery	CHARLES H. MAYO, M.D. Rochester, Minn.
Reconstruction Surgery	MAJOR EDGAR KING, M.C. U.S.A.
Head Surgery	LIEUT. COLONEL T. C. LYTTER, M.C. U.S.A.
Brain Surgery	CHARLES BAGLEY, M.D. Baltimore
Ophthalmic Surgery	JAMES BORDLEY, JR., M.D. Baltimore
Surgery of the Ear, Nose and Throat	C. W. RICHARDSON, M.D. Washington
Oral Surgery	VILRAY P. BLAIR, M.D. St. Louis
Discussion	GEORGE E. DE SCHWEINITZ, M.D. Philadelphia
Orthopedics	E. G. BRACKETT, M.D. Boston

*Wednesday October 24 8 P M Gold Room Congress Hotel*

Symposium—Antisepsis	H. D. DAXIN, M.D. and ALEXIS CARREL, M.D.
New York	ROBERT G. LECONTE, M.D. Philadelphia
War Efficiency and Venereal Diseases	WM. O'NEILL SHERMAN, M.D. Pittsburgh
Surgery of the Chest	RATMOND FOSDICK and W. F. SKOR, M.D. New York
	SAMUEL W. ROBINSON, M.D. Rochester, Minn.

*Thursday October 25 8 P M Gold Room Congress Hotel*

Presidential Address—Scope of Usefulness of Radium in Gynecology	JOHN G. CLARK, M.D. Philadelphia
Brain Surgery	CHARLES H. FRAZIER, M.D. Philadelphia
Discussion by ALLEN B. KAYE, M.D. Chicago.	
Surgery of the Stomach	WILLIAM J. MAYO, M.D. Rochester, Minn.
Discussion by A. J. OCHSNER, M.D. and L. L. McARTHUR, M.D. Chicago.	



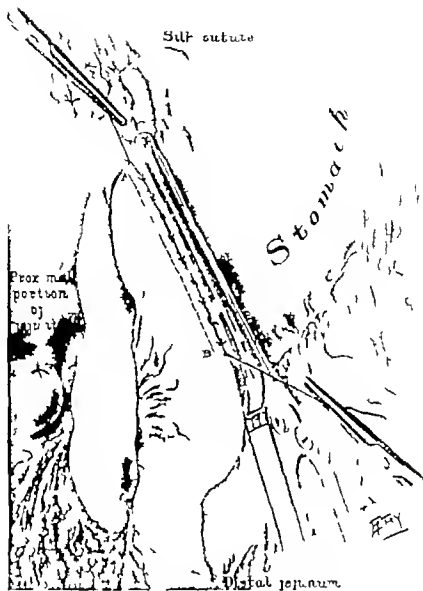


Fig. 3. First row of interrupted silk sutures uniting the proximal portion of the jejunum to the posterior wall of the stomach. Antecolic. (Donald C. Balfour)

# SURGERY, GYNECOLOGY AND OBSTETRICS

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## RESTORATION OF GASTRO-INTESTINAL CONTINUITY BY MEANS OF ANTICOLIC GASTROJEJUNOSTOMY FOLLOWING PARTIAL GASTRECTOMY FOR CANCER OF THE PYLORIC END OF THE STOMACH<sup>1</sup>

By DONALD C. BALFOUR M.D. RICHMOND, MINNESOTA

THE cure of cancer of the stomach by surgical removal is being accomplished with an increasing frequency a fact largely due to the progress which has been made in the two most important phases of the subject, viz diagnosis and treatment.

Prominent factors which have contributed toward more accurate and earlier diagnosis have been the better appreciation of the clinical history the x-ray and the relative values of each the recognition of the necessity of most thorough investigation of early symptoms and particularly of the danger of neglecting the chronic gastric ulcer and a decreasing pessimism on the part of both the laity and the medical profession in their attitude toward cancer of the stomach.

The surgical treatment of cancer of the stomach has become more efficient not only because of the foregoing but because of the following facts. There is a general improvement in surgical technique a more exact knowledge of the surgical limitations in gastric cancer and the development of the technical methods employed in gastric resection.

The methods of gastric resection which have been most successful in our clinic during the past decade are

1 The Billroth No II operation which gave decidedly better results than any of the

preceding methods. It was employed for some years with much satisfaction. This operation of resection and suture posterior gastro-enterostomy was necessarily varied by circumstances so that anterior gastro-enterostomy and a Murphy button anastomosis occasionally were indicated and made use of to re-establish the continuity of the gastro-intestinal tract.

2 About four years ago the so-called Polya operation which seemed to possess quite obvious advantages over the Billroth No II in a considerable percentage of cases was adopted in the clinic. This operation described by Dr W J Mayo in 1915 while followed by better results than the Billroth No II still presented technical difficulties under certain conditions particularly following extensive gastric resections. In such cases it was sometimes quite impossible to bring the gastric stump with the attached jejunum satisfactorily through and below the level of the opening which had been made in the transverse mesocolon.

3 During the past few months we have used the following method — a method which has given better results than any we have heretofore used and inasmuch as it has other advantages we now consider it the best routine operation for the removal of gastric cancer.

<sup>1</sup>Submitted for publication September 9 7

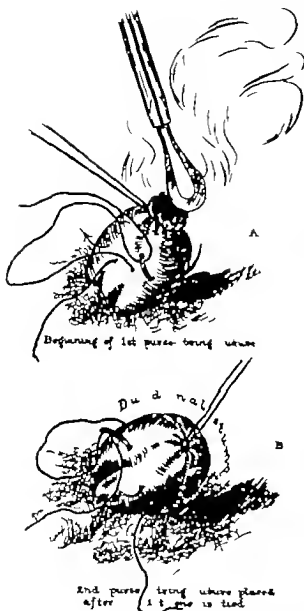


Fig. 1 The end of the duodenum is transected and tied with ligature. The actual cautery used for sterilizing stump beyond ligature. The purse-string suture in place. B The stump inverted and first catgut purse-string suture tied. Second catgut purse-string suture in place below the first. A few interrupted silk sutures may be placed to draw together the sheath of the pancreas and omentum in the vicinity thereby burying the end of the duodenum.

The resection is carried out in the ordinary way with especial attention to such important points as the wide removal of gland-bearing tissue the avoiding of injury to the middle colic blood supply of the transverse colon the resection made well beyond the

cancer limits the cauterization of all cut mucous surfaces to prevent cancer-cell transplantation and the secure inversion and burial of the duodenal stump. The operative field is inspected and carefully isolated by trench packs and the second stage is carried out as follows (Figs. 1 and 2)

The first loop of jejunum is procured at a point about 14 to 18 inches from the duodeno-jejunal angle is marked. The jejunum is then carried up in front of the transverse colon and omentum and a segment of suitable size is chosen at the point already marked. This section of jejunum is lightly grasped with rubber-covered forceps and directed so that the proximal end of the loop will be approximated to the lesser curvature of the stomach. A series of interrupted silk sutures in the serosa is used for the first line posteriorly beginning at the greater curvature. All these sutures are placed before any are tied and the ends of the top and bottom sutures may be conveniently left as guides. The first suture line is about one half inch below the clamp on the cut-end of the stomach and on the side of the jejunum about three fourths of an inch from the summit of the loop. In extensive resections it is extremely important to get the best possible exposure of the lesser curvature for at this point it is occasionally difficult to make a secure anastomosis, and it is along the lesser curvature that inflammatory products frequently extend rendering the gastric wall friable and a distinct source of danger. Any measure in such cases which will prevent retraction of the lesser curvature should be utilized. We still find the right angled rubber-covered clamp of greatest service for this purpose. The jejunum is now incised on the line (Fig. 3 frontispiece) and the crushing clamp removed from the stomach. (If it has been possible at any previous stage in the operation to place without difficulty a straight rubber-covered clamp at a higher level on the stomach soiling by unevacuated gastric contents will be prevented.) Any actively bleeding vessels are ligated. The posterior row of the anastomosis uniting the posterior wall of the stomach to the inner cut edge of the jejunum is of chromic catgut. The stitches on the

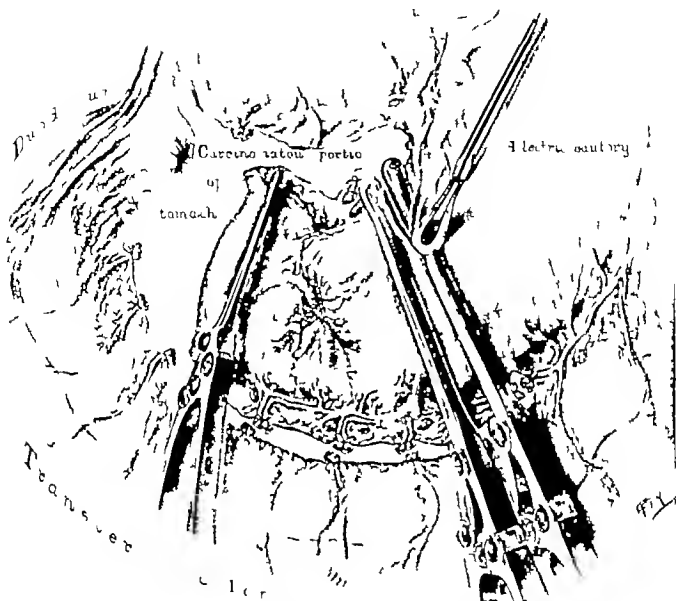


Fig. End of duodenum closed, vessels ligated and stomach and glands isolated with the carminous portion of the stomach. Section being made with an electric cautery knife.

gastric side should be taken after the edge which has been crushed by the clamp has been trimmed with the scissors. A second row of finer catgut may be used to advantage in the posterior line. The first chromic catgut suture is continued in front in the usual way to complete the closure. An interrupted silk suture line similar to that used posteriorly is placed anteriorly, particular care being taken to reinforce the angle of anastomosis at the lesser curvature. A few interrupted silk sutures are placed where necessary further to protect the anterior suture line and the suture

at the lesser curvature the stump of gastro-hepatic omentum which contains the ligated gastric artery being utilized as a support to the gastrojejunal angle at this point.

The procedure as described is applicable to the majority of cases (Fig. 4). When however chronic pyloric obstruction has greatly dilated the stomach the gastric outlet after resection is often much larger than is necessary for the anastomosis. Under such circumstances the outlet may be decreased by partly closing it at the upper angle with sutures as advised and practiced by Dr. C. H.

Mayo or the outlet may be approximated to a much smaller opening in the jejunum by suitable suturing. Thus if the gastric outlet is one third larger than the size of the opening desired in the jejunum the interval between all stitches on the gastric side should be one third greater than those on the jejunal side. The readjustment with which the stomach will adjust itself is of course largely dependent on the fact that its great size is abnormal and the stretched-out tissues tend to contract rapidly. However it has been our experience that there is no objection to an anastomosis of considerable size (Fig. 5).

The advantages of the antero-lateral (gastric) to side (jejunal) method are quite obvious. It has been our experience that it can be used in practically every case that it is simpler, safer and can be accomplished in less time than any other method. The operation may be completed well within the hour and if conditions for operation are favorable even within half an hour. Its

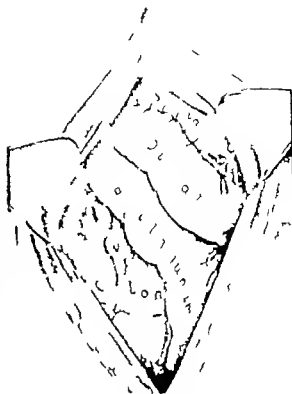


Fig. 5. Position of the anastomosis in relation to the tumor, as seen on exploration of the viscera after completing operation. Anteriorly wound ready for closure.

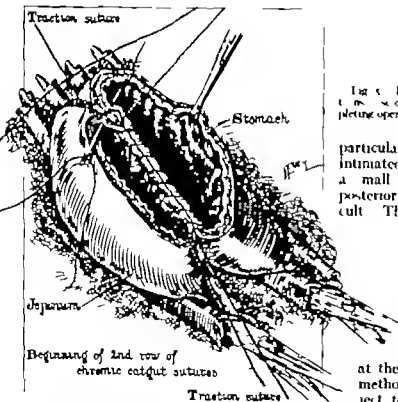


Fig. 4. Completion of gastrojejunal union by anastomosis through and through with use of chromic catgut.

particular advantage is seen as I have intimated in extensive resections when such a small segment of stomach remains that posterior gastro-enterostomy would be difficult. This fact makes it quite possible that not only will the method result in more radical operations in gastric cancer but by reason of this advantage it will occasionally permit resection in cases heretofore considered inoperable. No disadvantages in the method have been encountered and it has been the experience of the surgical staff

at the clinic that patients in whom this method has been employed are less subject to postoperative complications than are those who have been operated upon by other methods.

That the operation is of less risk than other methods is very definitely shown by our operative mortality statistics. From January 1907 to August 16 1917 in 318 resections by the Billroth No. II method there was an operative mortality of 13.2 per cent in 104 cases by the Polva method a mortality of 14.4 per cent while in 38 cases with the

method I have described the mortality was only 5.2 per cent. This comparison of operative mortality is quite fair inasmuch as the operations were done by the same surgeons in the same clinic with similar surgical indications.<sup>1</sup>

The statistics of the operative mortality following the Billroth methods and the Kocher method and segmental resections in the clinic are not quoted as they are not comparable.

## SECTION OF THE DUODENUM

By PEDRO ESCUDERO M.D. BUENOS AIRES

Sublect: Professor of the Medical Clinic

AND

RODOLFO E. PASMAN M.D. BUENOS AIRES

Internos of the Real Hospital

WE believe that a report of this extraordinary case of complete section of the duodenum which we have studied in the Rawson Hospital will be interesting and valuable. We know of reference to only one similar case which was cited by H. Meunier and which was seen at an autopsy and referred to by Movnhan in his book on duodenal ulcer page 281. A report of the case follows:

J. M., a workman age 60 had lived in Argentine for 40 years. His critical illness dated back only a year but he has had gastric symptoms for a longer period. He cannot describe his condition well for he is not an educated man. During his illness he has had periods of complete relief lasting one to three months at a time. His most important symptom is pain which comes immediately after meals. The pain is situated in the epigastrium and radiates to the left costal margin and to the dorsolumbar region sometimes he feels the pain between meals and at night but more often at the end of his meals. The pain moderates on pressure when he is lying down and when he is eating. The pain is accompanied with pyrosis and often provokes vomiting which brings immediate relief. The intensity of pain varies with the kind and quantity of food which he eats.

For a few months the patient has been very constipated. He has never suffered from melena or hematemesis. His appetite is good although he has lost 29 pounds in the last three months. Physical examination on entrance revealed the following: he was very thin almost without teeth the tongue was furred red and damp at the tip. The abdomen was scaphoid the liver was small the spleen not

palpable. There was pain in the celiac point but no other points were painful. There was no gastric clapping but succussion was positive. The cecum was dilated but not painful. There was no pulmonary effusion. Pulse 6 with 80 millimeters pulse tension. The arteries were hard. The scilicet arc was very pronounced. With the stomach tube, we obtained 50 centimeters of gastric contents which on examination showed hydrochloric acid 1.0 per cent and a total acid of 2.8 per cent. No mucus lactic acid or blood was present. With the Ewald test meal we found hydrochloric acid 1.35 per cent and total acid 1.95 per cent. No mucus or blood but plenty of pepsin was present. Digestion of carbohydrates and albuminoids was good. The urine was normal. Blood examination showed reds 3,030,000 whites 8,500 hemoglobin 65 per cent. Differential count of leucocytes showed polynuclear neutrophils 50.5 per cent eosinophiles 0.5 per cent mononuclears 9.5 per cent lymphocytes 30 per cent transition form 0.5 per cent. The Wassermann reaction was positive. The feces contained occult blood.

The radioscopic examination made the diagnosis clear. A Rieder test meal administered six hours before demonstrated a pylorus perfectly permeable. The hamuth was found in the cecum and ascending colon. We made another examination giving 100 grams of the Rieder food in the recumbent position (Fig. 2). We noted a shadow with a half moon shape which extended to the right costal margin. After all the food had been given the stomach was noted to be distended and situated low rather on the right (Fig. 3). It moved well on respiration and by palpation. We saw extensive contractions that commenced in the fundus of the stomach ended at the pylorus and followed each other regularly. There were no painful points.

The patient was seen again twenty minutes later



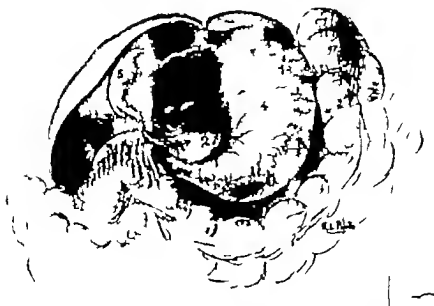


Fig. 5. Duodenal section. The cross indicates the pyloric opening. A, gall bladder; B, duodenum; C, stomach; D, pyloric opening; E, duodenum; F, stomach; G, gall bladder.

in the dorsal position and we observed a shadow very commonly seen in duodenal strictures (Fig. 4). A large black shadow (1) against the left diaphragm another on (B) with a semicircular form which extended from the left parasternal line to the right mammillary which reached the costal margin. Its inferior part is well limited the upper in the contrasty shaded field of fear limit. These two shadows did not change in either decubitus, left or right. We noted muscular contractions in the inferior shadow (B) that took half way without showing clearly the pylorus. The bismuth was seen progressing with difficulty (arrows) in the other part of the duodenum. The patient was made to walk and was observed lying down forty minutes after ward. The examination cleared the diagnosis (Fig. 5). At first the shadow observed was the same as the one in Fig. 4 but with intensive massage we provoked contraction of the stomach which made the shadows separate as can be seen in Fig. 5. The figure shows the stomach (E) ending with a point. The duodenal shadow well separated and touching the costal margin is shown at (D). This was not painful or movable on palpation. When we displaced the shadow (D) we moved also the superior part of the ascending colon (C) which we presumed adhered to the duodenum. With respiration the duodenal shadow moved well, on the contrary the colon did not.

An hour and fifty minutes afterward the patient was again seen in prone position (Fig. 6). There were remnants of bismuth in the stomach, with a prolongation (1) in the upper part. It takes the shape of half moon though the prolongation (A)

has not such intense shadow. The part (D) corresponding to the duodenum. It had an irregular form, was not painful, or contracted and moved at the same time as the colon. After second the patient was once more seen lying down two hours after the ingestion of the Riedel soup. We observed formed contents in the stomach (E) and the contents in nearly the duodenum. The first part is dilated reaching the costal margin the other he has small quantity of bismuth gives a moderate shadow and was seen to progress very slowly.

The patient's history was suggestive of ulcer of the stomach on account of the pain immediately after eating the radiation of the pain to the shoulder and increase on upon compression of the epigastrium in the dorsal position and by the ingestion of food. In addition to this there was gastric retention as shown by the stomach tube the hydrochloric hypersecretion when fasting the presence of blood in the gastric contents and by the presence also of fermented acids. Notwithstanding the presence of these symptoms, we did not think of stomach ulcer. We based our conclusion on the following. The washing out of the stomach for five days made the gastric intubation disappear completely. The radioscopic examination showed a rapid evacuation. It is also well known that duodenal and stomach lesions present very similar symptoms. But to radioscopy belongs the credit of making the diagnosis. We assured ourselves not only of the normal function of the stomach and the absence of any organic lesion but also of gastric hyperclinesia very frequent in duodenal lesions. We were able to demonstrate that bismuth remained in the first portion of the duo-

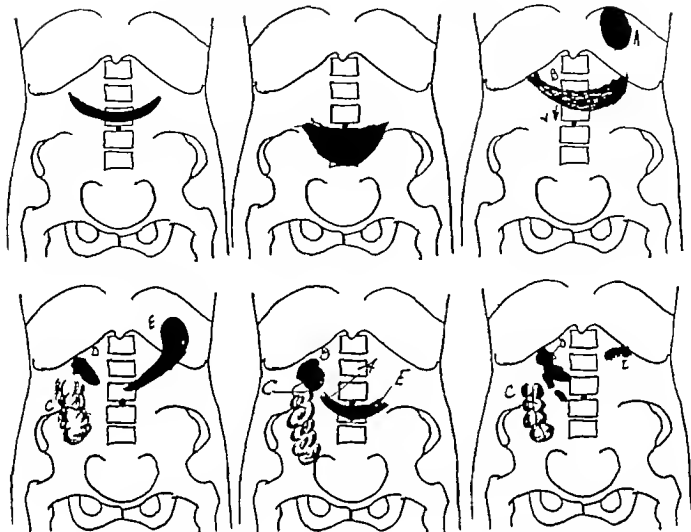


Fig. 2

Fig. 5

Fig. 3

Fig. 6

Fig. 4

Fig. 7

Fig. 2 Five minutes after a portion of the second Rieder meal. Patient examined lying down.

Fig. 3 Ten minutes after giving all the meal. Patient standing up.

Fig. 4 Twenty minutes afterward.

Fig. 5 Forty minutes. A massage of the abdominal wall has provoked an intense contraction of the stomach.

Fig. 6 One hour and fifty minutes. Patient in prone position.

Fig. 7 Two hours, stomach nearly emptied.

denum for two hours in several examinations. That only could be interpreted as a mechanical obstacle situated in the hepatic angle of the duodenum. We then made the diagnosis of stricture of the duodenum. The radioscopic examination showed us that the first portion had a size double to what is usually observed in a dilatation of the first part of the duodenum. The adhesions of this organ to the hepatic flexure of the colon could only be interpreted as being due to an inflammatory process. We then added to stricture of the duodenum the diagnosis of periduodenitis. We finally decided on a diagnosis of stricture of the duodenum at the hepatic angle dilatation of the first portion and periduodenitis.

As to the etiology since we investigated for and found the presence of a syphilis not acknowledged by the patient we treated him first by intravenous injections of mercury. He made such an apparently

rapid recovery that he refused to submit to any other treatment and left the hospital a month and a half after his admission.

He remained in good health three months with no dietetic or medicinal treatment after which his appetite failed and he felt epigastric pain one hour after his meals. This pain usually lasted twenty minutes. Then he commenced vomiting which relieved him immediately. The pain was not constant at first but in the last week it was of almost daily occurrence. He was not constipated. He returned to the hospital in a very bad state generally and much thinner. Palpation of the epigastrium caused him great pain. The gastric retention showed 3.9 per cent of hydrochloric acid and 5 per cent of total acid. With the Ewald test meal hydrochloric acid 1.4 per cent total acid 2.5 per cent. Dr. José Saralegui in charge of the X-ray

department: the Rawson Hospital reported the condition as it was observed months before. Both the chemical and radioscopic examinations called for an immediate surgical operation for the diagnosis was well established and the patient was doing badly. We also had in this unfortunate man a filiform stricture of the urethra to deal with, so we delayed the operation for a few days treating the stricture by gradual dilatation.

It is very difficult to determine what caused the reduced state to which the patient had arrived. Was it due to the ulcer or to the pharyngemia of auto intoxication from retention of bile?

The operation was performed by Dr. David Prand on April 6, 1916. The laparotomy disclosed the external formation of connective tissue over the stomach, the mesocolon and its spread in the shape of big reflected stars the walls of the stomach were very thick and edematous. In the proximity of the pylorus the walls of the stomach were still more indurated. The lesser curvature was firmly adherent to the concave surface of the liver and to the gall bladder. These adhesions extended also to the pylorus and the first portion of the duodenum. We thought there might be chronic perforation and decided that it was prudent not to attempt to separate the organs. A posterior gastro-enterostomy was performed. The post-operative care was as usual and nourishment was commenced 24 hours. Following the operation the patient had no other symptoms than those that were attributable to the urethral stricture. On the fourth day we performed an internal urethrotomy. The urine became normal again. The general state of the patient remained very poor. He died eleven days after the operation.

The postmortem showed the attachment of the stomach to the liver and gall-bladder. We found the gastro-enterostomy in good situation and with a patent mouth. Then we tried to separate the liver from the stomach finding a cavity artificially created that was the size of a small tamarind and surrounded by a smooth thick wall covering the neighboring organs. It was at first slight difficult to know how the cavity had been formed and which were the organs that surrounded it. By means of both a gastrotomy and a duodenotomy (second portion) and introducing a sound in each we observed that there was a true decapitation of the duodenum. The hole in the duodenum corresponding to the pyloric region was situated about  $1\frac{3}{4}$  inches from the pylorus. We made at that time a drawing as shown in Figure 1.

The hole in the duodenum was deeply situated in the cavity in relation to the Spiegelian lobe. The section was complete with seromuscular borders smooth the mucous membrane, on the other hand, herniated and was plaited thus making the cavity appear smaller than it really was. There was between the stomach and duodenum a distance of 3 centimeters. The cavity was limited above by the concave surface of the liver to the left side the

small curvature of the stomach to the right the gall bladder wrapped with adhesions below the stomach gall-bladder and mesocolon. The floor was formed by the thick parietal peritoneum. The cavity was empty whereas in the case of Meunier described by Moynihan there were remnants of food.

This case leads to a number of conclusions. The first is the advantage of making the diagnosis of ulcer of the duodenum at an early stage treating thus the ulcer and not the complications. There is no doubt that the remissions produced by the medical treatment are very deceptive and that it is much better to resort to the more radical surgical treatment. Our patient made such a rapid recovery with the mercurial treatment that no other seemed necessary as he was apparently doing well for four months. If we had not used mercury the patient would surely have consented to an operation. Another interesting feature of this case was the evolution of the process that made a complete section of the duodenum without giving peritoneal reaction. It was therefore difficult to discover the pathogenesis in this case. Moynihan, among other authors when he speaks of chronic perforations describes not only the formation of periduodenal abscesses situated in the neighboring organs but also those very far from the duodenum. These abscesses, as in the case described by Meunier involving first the intestine, may invade the wall of the gut and destroy it.

We did not find an abscess we found an empty cavity to which opened the two extremities of the first duodenal portion. As this cavity was bounded by a thick cover we believe that the functional work of the gastro-duodenal tract was not much disturbed. There is no doubt that the great acidity of the gastric juice that was retained more than two hours in this cavity caused inflammation, as the walls were not protected by the normal gastric mucosa. It is interesting to note the influence that this artificial cavity had on the gastric function. The stomach showed an insufficient pylorus almost permanent, as the bismuth was completely evacuated in two hours by very energetic contractions. We interpret the gastric retention

that the patient showed at the time of our examinations as a reflex into the stomach from the artificial cavity. In one examination we found blood in the stomach although there was no ulcer.

We must also emphasize the great advance in making radioscopic examinations in series. In our case we did not arrive at an exact diagnosis when we assumed there was a dilatation of the first portion of the duodenum and a periduodenitis but, looking over our figures once more and taking into consideration the autopsy findings and noting the exact relation between them we do not doubt being able should a similar case occur to make an exact diagnosis.

Has syphilis anything to do with the etiology of these ulcers? One of us (Escudero) and Dr G M Escalier in the meetings of the Medical Society (Buenos Aires 1915) spoke

in favor of the syphilitic origin of some of these ulcers. We regret not having in this case the microscopical proof but it was not possible to obtain it.

Some points in this case seem worthy of mention.

1 The slow course of the process.

2 The efficacious action of the medical treatment which restored the patient to health for four months.

3 The presence of adhesions with retractive shape irregularly distributed in the colon and mesocolon so far situated from the ulcer as to be not originated by it proves the existence of a process of long standing.

From what we have just said we do not affirm the syphilitic etiology of this ulcer but we would mention it as a cause that is hardly ever considered in connection with a duodenal ulcer.

## SOME CAUSES OF OCCASIONAL FAILURE IN THE OPERATIVE TREATMENT OF CHRONIC GASTRIC AND DUODENAL ULCERS<sup>1</sup>

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**S**URGEONS do not claim that operative treatment is invariably a sure cure for chronic ulcer of the stomach and duodenum. They claim only that a large percentage of ulcers is so cured while medical treatment is followed by recurrence in the great majority of cases. Cure after surgical treatment varies in different classes of ulcers. The percentage of cures is somewhat higher in duodenal than in gastric ulcers and in those with pyloric stenosis than in those without. Hence the introduction of various forms of pyloric exclusion to simulate pyloric stenosis.

Apart from a very considerable number of gastric ulcers treated by resection, mesogastric resection and excision, the majority of the ulcers we are considering is treated by gastrojejunostomy with or without pyloric exclusion. Moreover in all such cases except in mesogastric resection a gastrojejunostomy is or should be added so that with this

exception and the few treated by gastroduodenostomy gastrojejunostomy is employed in all cases.

Although a very large percentage of the cases in which gastrojejunostomy is employed is followed by excellent results reports multiply to show that further experience demonstrates that some of these relapse after a year or two or even later. What is the cause of this? Of course operative treatment does not insure a patient from acquiring a new ulcer but does the operative technique naturally lead to a new ulcer in some cases?

Peptic jejunal ulcers at or near the stomach have now been reported in a considerable number of cases. Von Eiselsberg (1) reported an unusually large number of them in his paper read in London in 1914 a surprisingly large proportion of them occurring in cases in which his method of pyloric exclusion had been practiced.

In October 1913 I operated on a nurse M. T. who had given symptoms for years and had had the appendix removed 5 years before. A posterior gastrojejunostomy was done for a moderately indurated duodenal ulcer using a continuous chronic catgut suture for the inner row and a continuous suture of silk or linen for the outer. The gastric symptoms were relieved for 3 months and then recurred. Medical treatment was tried but the patient grew steadily worse. Two X-ray series did not clear the diagnosis. A second operation was done exactly two years after the first. The duodenal ulcer had healed. From the outside the gastrojejunostomy looked absolutely normal with no induration and no adhesions. The stomach was opened disclosing the stoma, from the inner margin of which hung three or more inches of the suture and still more was pulled out from the wall of the stoma. There was no ulcer where the suture was hanging from the inner margin of the stoma. I searched for an ulcer in the neighborhood, in the stomach and jejunum, but found none. The operation was followed by complete relief of symptoms, which has continued to date more than a year.

It is very interesting to note that in spite of ulcer symptoms there was no ulcer and that the symptoms were relieved by the removal of the suture. It appears therefore that symptoms of recurrence of ulcer do not necessarily imply a peptic ulcer of the stomach or its neighborhood but may depend upon the irritation due to the traction on the suture end hanging from the inner surface of the stoma. It is impossible to say definitely in how many cases this holds, also whether an ulcer would have formed at the site of the suture before it was cast off. Probably in time in all cases the suture would be pulled out and cast off. Based on a few cases in which I have observed gastric symptoms occurring during the first year or so after operation, which have in time disappeared, my own opinion is that the working through of the non-absorbable suture may be accompanied by such gastric symptoms without ulcer formation and that relief follows the passage of the suture.

In any event, whether causing ulcer or not it is my opinion that the non-absorbable suture which has a tendency to work its way through into the stomach, is responsible for a majority of the cases of recurrence of symptoms after gastrojejunostomy for ulcer.

Since the date of the second operation on

the above case I have used no more non-absorbable suture and have found in a considerable number of cases that No. 6 chronic catgut answers perfectly for both rows of sutures. I would strongly urge this practice in all gastrojejunostomies.

I have met with a single case of complete closure of the gastroenterostomy opening with a fresh prepyloric ulcer. But as this unusual case of operative failure probably depended on a gastrojejunal ulcer (1) due to the use of non-absorbable suture, it can be prevented by the use of chronic catgut for all sutures.

Five years ago after a V-shaped excision of a gastric ulcer on the lesser curvature I was compelled to re-operate because the symptoms were relieved for only nine weeks. I did a gastrojejunostomy with considerable relief but the patient was not entirely cured until two years later when a von Eiselsberg excision was done proximal to the site of excision. At this operation the continued trouble appeared to be due to adhesions at the site of the excision of the ulcer and to a partial pyloric stenosis. I believe that traction on adhesions at the site of an ulcer accounts for some cases of recurrence of symptoms and that von Eiselsberg's excision is the most effective treatment.

I have found by experience confirmed by that of Mayo (3) Payr (4) and others, that excision without gastrojejunostomy does not cure the patient. I think that some of the poor results and recurrence of symptoms after operation for gastric ulcer are due to the use of excision without gastrojejunostomy.

My experience has made me dissatisfied with V-shaped excision, and in this Payr's (5) opinion bears me out so that I have determined to discard it in favor of resection or mesogastric resection. There remain, however a few cases where excision with gastrojejunostomy is indicated as the most available procedure. Thus in two recent cases of indurated ulcer on the lesser curvature near the cardiac end I was compelled to employ it as mesogastric resection would have been exceedingly difficult. I still believe that its very limited use will conduce to better permanent results in the operative

treatment of gastric ulcers and that gastrojejunostomy should always be added.

In a small percentage of cases of duodenal ulcer treated by gastrojejunostomy recurrence follows or the ulcer fails to heal. This occurs somewhat more often if there is no pyloric obstruction or if the latter exists to the first or second degree only. The stoma fails to drain sufficiently owing to the lack of pylorospasm or stenosis and if the gastric contents are not neutralized the passage of the acid chyme over the ulcer does not allow it to heal.

Hence to avoid occasional failure where there is no marked obstruction I believe that pyloric exclusion is theoretically indicated and should be tried until there is obtained a large series of cases that can be followed and studied to judge of the results of the procedure. Some method which will hold long enough to allow the ulcer to heal should be chosen. Personally I generally employ Wilms method using a strip of fascia from the anterior sheath of the rectus muscle. It is not necessary for the occlusion to be permanent. The results are good but whether better than without occlusion it is too early to say.

The results of pylorotomy resection and mesogastric resection are excellent and the mortality low. There is but little shock as there is so little loss of blood. In such cases the gastrojejunostomy is of course liable to the trouble already mentioned unless absorbable sutures are used.

Surgeons are not agreed as to the use of gastrojejunostomy in the treatment of perforated ulcers when the condition of the patient justifies it. Excellent results without gastrojejunostomy have been reported by Gibson (6) Shea (7) and others while Paterson (8) Deaver and others are very emphatic in urging its employment. Personally I favor it whenever conditions warrant it. It is only by the study of a large series of cases followed for two or more years that anything like a definite conclusion can be reached.

In the past year a case operated on at Hudson Street Hospital 17 months previously was operated on by me for recurrence of

symptoms for five months due to a persistent pyloric ulcer. A number of such cases is reported in the literature. Elliot (9) in 1912 collected 57 cases in which persistence of symptoms indicated subsequent gastroenterostomy and was relieved by it except in a few cases in which it was refused.

A certain though perhaps a small proportion of cases of perforated ulcer operated upon without gastrojejunostomy will give unsatisfactory late results on account of recurrence or stenosis.

Another reason for failure to cure by gastrojejunostomy is that it is done in improperly selected cases. Eight and ten years ago I operated on two cases who were neurasthenic and very neurotic. Judging by the symptoms there should have been an ulcer but none was found.

Gastrojejunostomy was done and the results were failures. I believe that in not a few cases a poor result follows gastrojejunostomy because there were no ulcers present and the treatment did not fit the disease. We should be particularly careful to demonstrate an actual ulcer in neurasthenic and neurotic cases before doing gastrojejunostomy. We must also bear in mind that gastric symptoms suggesting ulcer may often be due to an extragastric condition such as lesions of the appendix gall bladder pancreas etc.

Unless we can see or feel an ulcer the use of gastrojejunostomy is unwise leads to disappointment and discredits the surgical treatment of ulcer. At times it may be very difficult to feel a duodenal ulcer. This is especially true if there is very slight induration as is often the case with ulcers of the anterior wall. If the lymph nodes of the gastrohepatic omentum along the common duct and the hepatic artery are enlarged we should look for trouble in the duodenum gall bladder or pancreas. If the latter feels normal and the gall bladder does not look or feel pathological we should be suspicious of any slight irregularity in consistency of the duodenal wall and investigate it carefully. In such cases of suspected ulcer on the anterior duodenal wall I have found the red stippling test of frequent service.

In cases in which there is an actual ulcer of the stomach or duodenum there may also be an extragastric condition especially in the gall bladder or appendix which if not discovered and appropriately dealt with will continue to give stomach symptoms. It this is overlooked the natural inference is that the operation failed to cure the ulcer or to prevent a recurrence. In all cases therefore the appendix and gall bladder should be thoroughly explored and if found abnormal treated accordingly. Moynihan advises the routine removal of the appendix on the additional ground that there may be a causative relation with the ulcer.

Another cause of late unsatisfactory results is the neglect to remove the sources of origin of fresh ulcers. It is recognized that infection plays an important part in the etiology of ulcer. Hence the teeth and tonsils especially should be carefully examined to detect and cure any sources of infection. How rarely this is done especially in hospital cases! The same source of infection that was responsible for the original ulcer may after the latter is healed produce a new ulcer.

Then too the diet should be regulated until the ulcer has had time to heal. We should not rely on operation alone to cure the ulcer but add careful dietetic and if needed antacid treatment. In all cases I use a Lenzartz or a modified von Leube diet post-operatively for the first two weeks. After that the diet should be made more liberal but care should always be exercised and excesses strictly avoided.

How the injunction to be careful of the diet is observed by some is illustrated by the following case the only one that has returned to me for a second operation for a fresh ulcer.

W. H. a cook, operated on by me December 1912 by posterior gastrojejunostomy was well and free of symptoms nearly two years when after drinking heavily for three weeks he altered his medical service at Belle Isle Hospital complaining of nausea attacks, epigastric colic and a chronic cough with infiltration at the apex of the right lung. The gastric mucus was then normal. He

was again well until four months before his readmission March 20 1916 when he gave as his daily habit coffee ten to twelve cups, cigarettes twenty to forty, alcohol two to three pints of beer and occasional whisky. He was operated on a second time April 9 1916 when an indurated prepyloric ulcer situated antero-inferiorly and encroaching on the duodenum distally was resected. The former ulcer situated posteriorly had healed.

Whether his habits were responsible for the recurrence of the ulcer I cannot say. The condition of his teeth and gums would account for infection and his habits for an abnormal condition of his gastric mucous membrane and secretions. Unfortunately it is probably true that many if not most of our hospital patients cannot or will not eat as they should to avoid recurrence as long as they feel well.

#### CONCLUSIONS

The principal causes of the occasional failure of operative treatment to cure permanently gastric or duodenal ulcer are

1. Improper technique
2. Improper selection of cases.
3. Improper after-care and diet
4. The failure to remove other causes of gastric symptoms
5. The continued presence of the sources of infection

Fortunately all these causes are removable, so that in the future the results of the operative treatment of chronic gastric and duodenal ulcers should be far nearer perfect than they have been in the past.

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## DUODENAL DIVERTICULA

WITH REPORT OF A CASE ASSOCIATED WITH A DUODENAL ULCER<sup>1</sup>

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IN a review of the literature we have been able to find the reports of 76 well authenticated cases in which 97 diverticula of the duodenum are described. In addition roentgenologists have reported 11 cases in which 12 diverticula were present, some of which have been corroborated at operation. (Case 1916 Stewart, 1916) Only seven of the reported cases of diverticula of the duodenum occurred in the first portion.

Case Carman (1916) and others report a sort of sacculum or pseudodiverticulum arising from a duodenal ulcer scar or periduodenal adhesions as due to gall bladder disease. That the niche in duodenal ulcer is a rare condition is evidenced by the fact that Haudek and Carman have demonstrated it only twice and George about six times (Eisen, 1916).

Previous to Bauer (191) diverticula of the duodenum were considered from an anatomical standpoint only as all of them including his own were demonstrated at necropsy. Since the diverticula were the indirect cause of the death of two of his patients Bauer discusses the clinical symptoms. One having persistent vomiting and emaciation with pyloric insufficiency due to traction or pressure died from persistent emesis eleven days after a gastrojejunostomy. The other a patient with jaundice died from a hemorrhage into an intrathoracic struma. At necropsy biliary stasis was found to be due to an inflammation of a diverticulum involving the ampulla of Vater. Baldwin (1911) has shown that diverticula of the duodenum, except in the first portion are not relatively uncommon, since he discovered them in 15 duodena from 115 cadavers.

The clinical importance of the case we are reporting is in some degree lost because of its rarity as a surgical problem and because pathological changes are very infrequent in

diverticula of the duodenum. The interest lies however in the relation of the diverticulum to a duodenal ulcer its position in the duodenum its unusual size and its demonstration at operation. With the intention of presenting the cases of diverticula in the first portion of the duodenum, we have collected those reported heretofore.

Following are the descriptions collected from the literature some of which are abstracted.

1 Morgagni (1761) This specimen which was obtained from the body of a man who died of apoplexy was situated two finger breadths caudal to the pylorus the orifice being large enough to admit a finger. The sac exhibited no trace of pathological changes.

2 Rahn (1796) found a duodenal diverticulum in the emaciated body of a woman twenty two years old who had died of chronic emesis. This sac shaped diverticulum was closely related to the pylorus and presented a mucosal fold at its orifice not unlike that of the pylorus. The condition of gastropylorus was present in this cadaver.

3 Fleischmann (1815) Specimen 3, male 28 drowned. The ductus pancreaticus and the ductus choledochus opened separately each through a small duodenal diverticulum. Lying near these diverticula there was a third the size of a pigeon's egg and in the caudal first portion of the duodenum still another smaller though similar diverticulum.

4. Albers (1844) mentioned one diverticulum located in the horizontal portion of the duodenum. It was scarcely one inch long and presented a contracted orifice with a marked fold of mucosa.

5 Jach (1899) specimen 2 Immediately caudal to the pylorus a cylindrical diverticulum with a mouth large enough to admit the thumb extended 3 centimeters caudally dorsally and medially from the first portion of the duodenum. Because of its cephalad position this diverticulum had no relation either to the major duodenal papilla, though the opening of the diverticulum was on the same side, or to the head of the pancreas. The diverticulum was covered with loose connective tissue.

6 Jach (1899) specimen 3 male 58 carcinoma of the rectum. In the first portion of the duodenum 20 centimeters from the pylorus there was an obliquely placed diverticulum. Between this and the pylorus an orifice large enough to admit one finger



opened into a spherical diverticulum 0 centimeter deep the fundus of which passed cephalad to the pylorus. Its dorsal surface was not connected with pancreatic tissue.

7. Falconer (1907) male 54 died of self-inflicted gunshot wound. A diverticulum was present arising from the greater curvature of the pyloric canal  $\frac{3}{4}$  inch long and  $\frac{1}{4}$  inch in diameter. There was a smaller diverticulum just beyond the pylorus on the upper wall of the duodenum  $\frac{1}{4}$  inch in diameter and  $\frac{1}{4}$  inch long. There was a ring of hypertrophied muscle especially the circular muscle but also the longitudinal, around both diverticula. A section of the diverticula showed all coats of the stomach and duodenum. There were no adhesions or signs of inflammation.

#### REPORT OF AUTHORESS CASE

This patient was subjected to the usual thorough routine examination but all negative findings are excluded in this history.

Mrs. E. M. entered the University Hospital on the division of Dr. A. A. Law of the surgical service of Dr. J. E. Moore June 1, 1916.

**History.** Age 35. Has one child nine years old. The patient has been nervous and irritable the last two years. Occasional severe headaches. She does her own housework. Her weight varies usually about 35 pounds at present 145 pounds. She has always been bothered with indigestion. Her appetite is fair. In childhood, as far back as the patient can remember she has had so-called bilious attacks, abdominal pains with nausea and vomiting and on several occasions her mother told her she was jaundiced. At the age of eight years she had a very severe attack which kept her in bed for six weeks. From the age of eight to twenty years past she has had slight pains over right side of abdomen at intervals of six months or a year. These were of likely character not associated with nausea, vomiting, jaundice, constipation or fever. There is no history of attacks of diarrhea. At twenty a similar attack occurred as on previous occasions but exaggerated the patient being confined to bed. From the age of twenty to two years before admission the patient has had similar slight attacks at intervals of six months or more. Vomiting has been only occasional but nausea has been more frequent. For the last two years the symptoms have become more frequent and aggravated. The patient is not free of symptoms for more than two or three days at a time. Sometimes the pains have been colicky in character starting over McBurney's point radiating about the right lumbar region to the back. These pains last for about one and a half hours and the patient has to go to bed. No history of hematemesis or melena. The patient sometimes wakes up at night with pain in the epigastrium. This pain lasts until the next meal, and is relieved by taking soda bicarbonate of food.

**Physical examination.** Patient is a well developed and well nourished woman. There is very definite

muscle rigidity, spasm, and tenderness over the right of the epigastrium more marked just to the right of the midline 4 centimeters above the umbilicus. The stomach distended with gas reaches 5 centimeters below the umbilicus. Ewald one hour test meal before operation. Amount 40 cubic centimeters dark brown. Total acid 73 free, 36 determined by using phenolphthalein and dimethyl-amido-azo benzol. The hydrogen ion concentration determined by the gas chain method (by G. L. M.) equals  $26 \times 10^{-4}$  or  $pH$  equals 3.6. A roentgenogram (Fig. 1) was taken before operation.

**Operation (by Dr. Ritchie) June 30, 1916.** Right rectus incision. The stomach and duodenum were quite markedly distended with gas. On the anterior surface of the duodenum, near the superior margin, there was a stellate scar slightly hemorrhagic around its borders typical of a chronic ulcer which involved the portion just caudal to the pylorus. The pylorus was patent admitting the tip of the index finger. Just below the pylorus on the lower side of the duodenum there was a diverticulum, 5 centimeters in length and 3.5 centimeters in diameter distended with gas. This was egg-shaped with a narrow isthmus that easily admitted the tip of the finger. Surrounding this opening into the sac was a hypertrophied ring of muscle. The all of the sac was partially invaginated by plication. The sac of the ulcer was invaginated with a few Lembert sutures. A typical short loop posterior gastro-enterostomy was done using interrupted linen and chromic catgut sutures.

The interesting points to be discussed are the origin of the diverticulum, its relation to the duodenal ulcer and the selection of operation.

Diverticula arise according to Busch, (1911) least frequently in the stomach, followed in order by the duodenum, pharynx, esophagus, ileum and colon.

Chamel (1710) first described a duodenal pocket in a woman eighty years old situated at the junction of the duodenum with the bile-duct and containing 22 stones. The first typical duodenal diverticulum was described by Morgagni (1761).

Diverticula have been classified by most authors as congenital and acquired. These may be subdivided into true and false. A true diverticulum presents in its walls all coats of the intestine. In the false variety the muscularis is wanting the walls then being formed by mucosa and submucosa. The presence or absence of peritoneum depends upon whether the diverticulum is on the free surface or on the mesenteric border.

projected between the two layers of mesentery. Both true and false diverticula may be produced by traction from tumors of adherent organs in ptosis especially by the ductus choledochus (Keith) by scar tissue or atrophy of the pancreas (Roth Edel).

Klebs (1869) considered false diverticula as herniations of mucosa through the muscularis produced by traction on the mucosa by blood vessels piercing the muscularis. This relation of diverticula to the blood vessel has been corroborated (Edel Hanseemann Hanau Davis Gordinier and Sampson and Fischer) although pulsion has been found of more importance in its origin than traction. These writers describe pulsion diverticula of the false variety as hernial protrusions of the mucosa related to the veins along the mesentery perhaps associated with some predisposing cause as muscular weakness. Graser in addition emphasizes the relation of the non mesenteric false diverticula to the veins. He states that a relaxation of the venous sheaths is produced by blood vessel stasis which predisposes to diverticula.

These authors noted further that in experimentally produced diverticula by filling the intestines of cadavers with water they ruptured regularly into the mesentery. Chlumsky (1890) found upon the living animal contrary to the previous results that the rupture occurred opposite to the mesentery — never into it — but that ten or more hours after death the intestines ruptured into the mesentery. Beer (1904) says there is no weak place at the mesentery and that Chlumsky's results are corroborated by clinical findings in ileus where the peritoneum and muscle usually the circular tear first opposite to the mesentery.

Beer and Telling (1908) state there must be a change in the resisting powers of the intestinal wall because diverticula exist particularly in old people whose intestines are more or less worked out therefore there must be a muscular weakness which accounts for the diverticula. Large areas of weak muscle wall form true diverticula small areas the false. These findings the authors state correspond to the close relation of the blood vessels to the diverticula the venous sheaths

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Fig. June 20 1906. Before operation. The shadow of the diverticulum is shown arising from the duodenum just below the pylorus.

simply point the way. Wilson (1907) describes areas of marked thinning of the muscle even where no diverticula had developed. Relaxation of the duodenum and fatty degeneration of the muscularis have also been advanced as predisposing causes (Roth 1872).

Several factors point to a congenital origin for true diverticula of the duodenum. In most of them there is an absence of any pathology such as ulcers tumors stones worms adhesions or changes in the intestines liver or pancreas. A case of Shaw cited by Buschi was undoubtedly congenital with atresia of the duodenum. In embryos of thirty to sixty days the duodenal lumen is normally more or less obliterated. The proliferation of epithelium early produces vacuoles or pits. The outer surface of the epithelial tube is generally smooth but frequently the masses of cells surrounding the vacuoles produce local bulgings of the basement membrane. Later the vacuoles confluence to reestablish the lumen (Keibel and Mall 1912).

The case which we report is exceptional because of the presence of a large evident

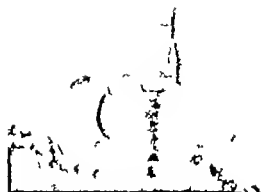


Fig. 2. This roentgenogram is taken both before and after operation and shows the diverticulum shaded. The region of the diverticulum is pointed out by a straight line and may denote the partial position of the diverticulum.

duodenal ulcer which though entirely separate must be taken into consideration when discussing the cause of the diverticulum. The history goes back to early childhood which suggests the possibility of congenital origin. It is readily conceivable that a diverticulum in any part of the duodenum may find its beginning in one of the embryonal vacuoles which failed to coalesce. The internal pressure of fluid may in time cause this vacuole to become pathological.

Buschli however observes but little tendency to the formation of diverticula by internal pressure from the stomach is because of the fluidity of duodenal contents and believes that it is would need to be of high grade in order to produce them.

The opening of the diverticulum was nearly but not exactly opposite to the ulcer. Recent studies in roentgenography by Carman (1916) show that in duodenal ulcer a spastic incisura of the duodenal bulb produced by a spastic contraction of the circular muscle fibers in the plane of the ulcer is frequently shown in the roentgenograms as an indentation of the opposite curvature. We suggest that this spas-



Fig. 3. Three months after operation. The diverticulum is filled with contrast medium.

tic incisura as well as the relaxation of the duodenum with ptosis would be predisposing to the development of a diverticulum particularly cephalad to the incisura. Such an explanation would fit our case and could we believe be applied to the third specimen of Jack (1899) where there was an oblique cicatrix a centimeter from the pylorus, and between these arose the diverticulum.

#### ELLATION OF OPERATION

The situation presented a nice surgical problem. An excision of the sac was first considered. The opening of the diverticulum was found on the under and lower side of the duodenum which would lead the operative field toward the pancreas and at the lower end of the sac to a point extraperitoneal. It would have involved removing some part of the lower side of the duodenum without the possibility of recovering with peritoneum. Since reviewing the anatomy and the several theories of origin, the possible close association with blood vessels would have rendered such excision a dangerous procedure owing to the possible interference with blood supply to the duodenum. The deciding point at the time against excision was chiefly a mechanical

one of reperitonization. A Finney pyloroplasty would have led the opening of the stomach into the sac and it was impossible to get far enough under to attain a good peritoneal base while the m m suture would have gone through tissues of questionable viability. A pylorotomy would have been the proper procedure and though we desired the specimen, another mechanical obstacle arose the question of room for invagination of the duodenum without involving the ampulla. Possibly this objection was fanciful, but as the sac extended for two inches along the side wall of the duodenum such a catastrophe had to be considered. There was also in view of the higher mortality of pylorotomy the probability that more conservative measures would be sufficient. These were undertaken as above described.

*Subsequent history.* An immediate and uneven recovery followed the operation. On the twenty-first day the second roentgenogram was taken (Fig. 2) and shows the diverticulum obliterated except for a half moon shadow which may be interpreted as a part of the cavity still open. Symptomatically the patient at this time three months following has not been so free from pain and discomfort in years. The third roentgenogram (Fig. 3) was taken three months after operation. Other roentgenograms four hours after a barium meal made at this time showed a portion still remaining in the stomach and a small oval shadow in the region of the diverticulum. Immediately following was an attack of nausea and vomiting of acid stomach contents. This was quite transient and relieved by antacids but may be a precursor of future trouble.

In conclusion we will outline briefly the unusual features of the case. First, that the diverticulum was demonstrated at operation; second the unusual size it being one of the largest reported; third the position in the first portion of the duodenum just below the pylorus and the last and most important feature that it is the only case reported where a diverticulum was found in close proximity to an ulcer of the duodenal bulb.

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# TUBERCULOSIS OF THE STOMACH WITH REPORT OF A CASE OF MULTIPLE TUBERCULOUS ULCERS

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From the Mayo Clinic

**T**UBERCULOSIS of the stomach was encountered only once in a series of 2501 gastric operations in the Mayo Clinic from the year 1912 to 1915 inclusive. The fact that in this instance resection was done supposedly for carcinoma with partial obstruction stimulated the following investigation of the literature.

## HISTORICAL

As nearly as could be ascertained tuberculosis of the stomach was first mentioned by Barkhausen in 1824. From this date to the discovery of the specific organism by Koch in 1882 a fair number of cases were reported, the best report being that by Litten in 1876. Litten's description is nothing short of classical. His case presented a single ulcer 4.2 cm. by 3.2 cm. on the anterior wall in the region of the lesser curvature which on microscopic examination showed typical caseating tubercles with giant cells containing peripherally-situated nuclei.

In 1875 Breu gave a good gross and microscopic description of a case with ulcers and pyloric stenosis resulting from a firm scar. In 1879 a good gross and microscopic description was published by Talamo of a case in a female child 4.2 years old with seven ulcers scattered over the mucous surface from cardia to pylorus. In 1881 Föpinger reported two interesting cases, both those of males, 30 and 55 years of age. A good gross and microscopic description (see miliary tuberculosis under types of lesions) accompanied this report also.

Regardless of the thoroughness with which the above-mentioned cases have been described, however, there is a certain element of doubt as to a positive diagnosis of tuberculosis because of the fact that the bacillus of tuberculosis was not discovered until 1882. The first to demonstrate the specific organism in the walls of a gastric ulcer was Coats in 1886.

Thereby he eliminated all doubt as to the etiology of the lesion. Since that time the specific organism has been demonstrated in a fair number of cases. It was first accomplished in the United States by Musser in 1890.

While from time to time a fairly large number of cases has been reported the majority will not stand when put to a critical test. Kuehl in 1889 reported 7 cases, 5 of the ulcer type and 2 with tubercles. He demonstrated the tubercle bacillus in 2 cases, 1 of each type. He also mentioned 7 other cases but a microscopic examination was not made. In 1897 Hamilton, after a critical but incomplete review of the literature was able to find only 15 positive and 9 probable cases to which she added 3 positive cases. Blumer in 1898 collected 30 authentic cases from the literature to which he added 1 positive case. Summons in 1900 reported 8 ulcer cases and 4 of the miliary tubercle type. Glaubitt in 1901 reported 47 cases (40 of the ulcer type and 7 with tubercles) from 12,528 necropsies, 2.247 of which were tuberculous, i.e., 0.38 per cent of the total number of cadavers and 2.1 per cent of those that were tuberculous. Przewoski in 1902 reported 5 cases of tuberculous gastric ulcer in all of which the tubercle bacillus was present. In 1902 Arling reported 14 cases he had collected from the literature with the exception of 1 personal case. Ricard and Chevrier in 1905 collected 107 cases in which the findings in 16 cases of tuberculous pyloric stenosis were reported. Four of these were personal cases. The authors of the two latter reports were not very critical and accepted a good many cases that should have been rejected or classified as doubtful.

## TYPES OF LESIONS

After a thorough review of the literature it will be found that gastric tuberculosis may

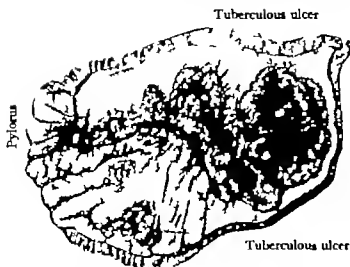


Fig 1 Case 152 98 Multiple tuberculous gastric ulcers. Drawing of gross specimen.

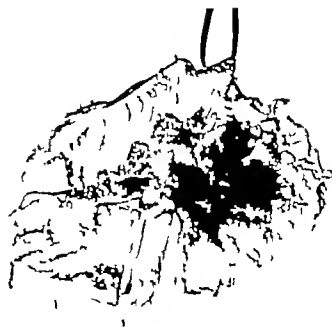


Fig Case 152 98 Photograph of gross section shown in Fig

be divided into 6 types as follows (1) ulcer (single or multiple) (2) miliary tubercle (3) solitary tubercle (4) pyloric stenosis (5) tumor or nodule (single or multiple) and (6) lymphangitis

1 *Ulcer (single or multiple)* There is practically no difference between the tuberculous gastric and the tuberculous intestinal ulcer. Tuberculous gastric ulcers range in size from the slightest erosion to 20 cm by 10 cm (Glau bitt). Some are very shallow others very deep extending through to the serosa and even perforating. They vary in number from a single ulcer to large numbers. In her first case Hamilton reported from 115 to 120. Sometimes they are associated with miliary tubercles.

2 *Miliary tubercles* Miliary tuberculosis of the stomach is usually associated with a general miliary tuberculosis. An interesting case of this type was reported by Wilms in a child 9 months old. Wilms holds that miliary tuberculosis of the stomach may be frequently associated with general tuberculosis that the postmortem changes in the stomach mucosa twelve or twenty four hours after death are such as to obscure the miliary tuberculosis. Simmonds believes that miliary tuberculosis of the gastric mucous membrane is not a rare occurrence.

In one of Eppinger's cases tuberculous ulcers and miliary tubercles of the stomach were associated with chronic tuberculosis in the

upper lobe of the right lung. In the other case there was an old tuberculosis in the apex of the right lung miliary tuberculosis of both lungs and liver and tuberculous ulcers in the stomach. Eppinger concluded that in both cases the gastric tuberculosis was of a general acute type.

3 *Solitary tubercle* The solitary tubercle is very rare. Van Wart reported an interesting case in which the tubercle 3.5 cm in diameter was located 6 cm from the cardiac orifice on the greater curvature. The same patient had small simple ulcers near the pylorus chronic peritonitis chronic pericarditis chronic pleuritis and bronchopneumonia. It was not possible to demonstrate tuberculosis in any organ other than the stomach. Van Wart concluded. It is impossible to state whether the lesion was primary in the stomach but there is no definite evidence to the contrary.

Another interesting case was reported by Barchasch. In this instance a solitary tubercle of the stomach was associated with tuberculosis of the lungs and lymph glands and carcinoma of the cardia of the stomach and oesophagus.

4 *Pyloric stenosis* Tuberculous stenosis of the pylorus is of two types the true and



Fig 3 (Case 598) Photomicrograph of section of large ulcer at junction of base and border showing one definite and three indistinct tubercles (slow power)



Fig 4 (Case 598) Definite tubercle Fig 3 shows long giant cells (high power)

the false. The true type includes cases in which the pylorus is obstructed by an old tuberculous ulcer with an extensive amount of scar tissue and tuberculous granulations or by a diffuse nonulcerative tuberculosis of the pylorus. A large number of cases have been reported as tuberculous stenosis of the pylorus when as a matter of fact they should come under the false type the tuberculous process being extragastric. The stenosis of this type is brought about by enlarged tuberculous peripyloric lymph glands or by a tuberculous peritonitis in the region of the pylorus accompanied by adhesions often involving other organs in the process. Both types have been described by Ricard and Chevrier.

5 *Tumor or nodule (single or multiple)*  
A case of this kind was described by Cone in which there were three types of nodules with a general acute miliary tuberculosis. The first type was due to a connective tissue overgrowth or to irregular fibrous contraction and the second to an atypical glandular growth. The third was specifically tuberculous.

6 *Lymphangitis* Reports of tuberculous lymphangitis of the stomach are rare. A good case has been described by Dewey—that of a man 45 years of age who had in addition to the gastric tuberculous lymphangitis

tuberculosis of the lungs, tuberculous tracheobronchial lymph glands and tuberculous ulcerative colitis. He was extremely emaciated weighing only 64 pounds.

#### MODE OF INFECTION

The stomach may be infected with tuberculosis by at least four routes: (1) the mucosa (direct infection), (2) the blood stream, (3) the lymphatic system and (4) continuity and congruity of structure.

It is safe to say that infection of the normal mucosa of the stomach is difficult. However it seems reasonable to conclude that a lesion associated with reduced acidity renders such infection easier. It is a well known fact that a good many tuberculous patients are afflicted with disease of the stomach.

Marfan found a terminal gastritis in 18 of 27 phthisical patients. A fair number suffer from simple gastric ulcers such as the cases of Papellier (3 cases), Chambers, Cruveilhier, Toulmouche (5 cases), Heine and others.

Happel and Blumer reported a case of advanced pulmonary tuberculosis accompanied by round ulcers of the stomach and an absence of free hydrochloric acid. While a microscopic examination of material scraped from the bases of the ulcers showed many tubercle bacilli it was impossible to demonstrate the bacilli in the depths of the ulcers.



Fig. 5 Case 52198 Tubercle bacilli in the depths of the large gastric ulcer (1400 diameters)



Fig. Case 52198 Ph. tomograph of section of the apex of the left lung showing giant cells, necrotic areas and round cells.

or to find an histologic picture of tuberculosis. This case proves that in the absence of free hydrochloric acid tubercle bacilli may come in contact with an eroded area of the stomach and still not produce tuberculosis of the organ.

Cases have been reported in which the stomach was affected with both tuberculosis and cancer (Claude Barchasch, second case Lyle Borst and Simmonds). In such instances it seems that it would be rather difficult to prove which was there first.

Various writers ascribe the gastric tuberculosis in the cases they report to the swallowing of sputum containing tubercle bacilli (Kuehl 7 cases Ellis first case and others).

Duerck states that in order to infect the mucosa a break in the continuity of the mucosa and a neutralization or a lessening of the acidity of the gastric juice are necessary. According to Birch Hirschfeld tuberculosis of the gastric mucosa may occur only when active tubercle bacilli attack an eroded area. Hamilton suggested that in her second case ecchymoses may have been the forerunners of the small erosions the tubercle bacillus being responsible only secondarily for the further destruction. Wilms states that gastric ulcers may occur in the absence of tubercle bacilli being due to embolic plugs in the vessels.

According to Arloing the blood stream is the most probable route of infection. He bases his opinion on the results of experimental work. Other authors also believe this to have been the route of infection in their cases (Cone Wilms Simmonds 4 cases).

According to some writers the lymphatic system plays an important part in gastric tuberculosis. Baumgarten believes that tuberculosis of the stomach always begins in the lymph follicles never in the mucosa or any other part of the wall.

Wilms states that in the stomachs of children lymph follicles are very few in number though they increase in adults he also states that in his case the follicles were not responsible. Barbacci considered the lymph follicles the primary seat of infection. Dobrowolski has shown that the lymph follicles are not always so few in the human stomach. In catarrhal gastritis they are markedly increased and he has applied to this condition the term gastritis granulosa (see Marfan under Mode of Infection).

That tuberculosis may enter the stomach from adjacent tuberculous lymph glands is evident from the case of Claytor and Wilkinson in which the tuberculous glands were intimately fused with the base of a tuberculous gastric ulcer. Chiari had a similar case. Rosset thought that in his case the tuberculosis was primary in the lymph



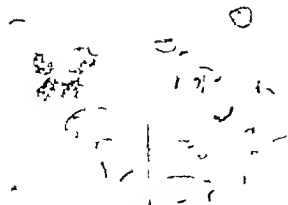


Fig. 7. Case 594. Tubercle bacilli smear from surface of the left lung (600 diameters).

Fig. 8. Case 594. Two tubercle bacilli in the depth of the lung tissue end-to-end (600 diameters).

glands at the hilum of the left lung and that it infected the retrogastric lymph glands and then the stomach by a blockade of the lymph stream. This patient had a tuberculous ulcer of the cardia.

Tubercle bacilli may enter the lymphatics of the stomach and set up a tuberculous lymphangitis as was proved in Dewey's case by the finding of the bacilli in the lymph vessels and tuberculous ridges following the lines of these vessels.

Infection by continuity and contiguity of structure is believed by some to be important.

Rokitansky stated that tuberculosis of the stomach occurs as a result of intestinal tuberculosis which has advanced to an extreme degree (continuous involvement). In his opinion the lymph glands of the stomach bear the same relation to tuberculosis of that organ as the mesenteric glands bear to tuberculosis of the intestines. His first statement has not proved entirely correct as cases of gastric tuberculosis have been described in which the intestines were entirely free from tuberculosis (Latten Eppinger 2 cases, Brechemin, Mathieu and Remond, Van Wart, Lyle Gossmann and the writer).

Ducrocq stated that very probably a large number of the reported cases of tuberculous ulceration of the stomach are due to the entrance of the bacilli not from the inside but from the peritoneal surface because of

a general or local peritonitis. Ellis' second case is an example.

It is possible for the stomach to become infected with tuberculosis by direct extension from adjacent organs such as occurred in the case reported by Winternitz.

In a number of instances infections by the lymph stream and by continuity and contiguity of structure are indistinguishable.

#### RELATIVE IMMUNITY

In 1870 Orth, by feeding tuberculous material to rabbits was able to produce tuberculosis in various parts of the body. The lymph glands were involved 7 times out of 9. In the stomach he found hemorrhagic erosions twice and an ulcer once. This ulcer was only 7 or 8 millimeters in diameter. From his microscopic description it seems that the ulcer was not tuberculous.

In 1883 Falk took particles from tuberculous lungs and caseous particles and pus from cavities immersed them in the digestive juices and injected them into the peritoneal cavities of guinea pigs. The result except for a local reaction was negative. He then allowed the tuberculous material to putrify and still obtained a negative result. Next he took tuberculous material from bodies that had been dead for eight days and kept at medium temperature but found that it had lost its virulence to a certain degree. He produced tuberculosis by injecting into a guinea pig a piece of tuberculous material which had been obtained from a cow and soaked in gastric juice for several days.

Frank in 1884 took small pieces of tuberculous lung let them stand in water for twenty-four hours, stained some of the fluid with Ehrlich's stain and found tubercle bacilli in great numbers. He then made up the following solutions with the solution containing the tubercle bacilli: (1) 1 to 1000 pepsin, (2) 1 to 2000 pepsin plus 0.05 of 1 per cent to 0.1 of 1 per cent HCl, (3) 0.05 to 0.1 per cent HCl and (4) 0.3 of 1 per cent bile.

The above solutions were incubated at from 37 to 38° C. and after from one to six hours 5 to 8 cubic centimeters of each were injected into the peritoneal cavities of rabbits and guinea pigs. At the same time some of

the original solution was injected into rabbits as a control. Those that died before seven teen days after inoculation showed no tuberculous infection. After that time they showed definite symptoms and all that were killed or died after six weeks showed general tuberculosis. The strength of the formulas was increased with the same result. According to Frank, these experiments showed two facts (1) that the material was really infectious and (2) that pepsin HCl and hile had no effect.

Sormani in 1884 concluded that the bactericidal action of gastric juice on tubercle bacilli is efficient and that gastric diseases cause this action to disappear.

Wesener in 1885 placed tuberculous particles in artificial gastric juice at 38° C for some hours. He then inoculated the cæcum of rabbits obtaining positive results. Five injections of the same material into the anterior chamber of the eye also proved positive.

Fischer in 1886 concluded that the gastric juice is inefficient.

Zagari in 1889 fed dogs for three or four months on material containing many bacilli that had been obtained from phthisical patients; he fed them also organs from tuberculous animals. He recovered numerous bacilli in the faeces that were active for guinea pigs. In his opinion the bacilli went through the digestive tube of the dog without noticeable change because of their short stay in the stomach. *In vitro* and at 38° C the bacilli put in contact with the gastric juice of a dog containing 0.1652 free HCl per 1000 for three or four hours were still very virulent. After seven, eight, and nine hours they produced only a local glandular tuberculosis and after eighteen to twenty four hours of contact, they were without action.

Straus and Wuertz in 1889 mixed *in vitro* pure gastric juice of a dog with a young and virulent culture of tubercle bacilli. Tubes containing 1 cubic centimeter of gastric juice mixed with the culture were put in an oven at 38° C for a time varying from one to forty eight hours. Rabbits that were inoculated by the contents of tubes that had remained in the oven from one to six hours died with generalized tuberculosis; those that were in

oculated with the contents after eight to twelve hours in the oven developed only a local abscess without any tendency to generalization (the bacilli were dead or attenuated). The bacilli lost all activity if they remained in the oven more than eighteen hours.

Kurloff and Wagner in 1890 added to artificial gastric juice tubercle bacilli from cultures or tuberculous masses and placed the bacilli in the stomachs of dogs through previously made fistulas. The results were negative even after seven hours of contact.

In 1896 Kjanowski arrived at the same conclusion as to the viability of the bacilli.

Schoull in 1891 proved that the gastric juice of cats is not bactericidal.

Cadiac and Bournay in 1893 at the Veterinary School of Lyons conducted experiments to ascertain the bactericidal action of the digestive juices and the possibility of contagion by faecal matter. They found that digestion *in vitro* had not the same value as digestion in life. It was their aim to approach the natural means of contagion. They believe that the bactericidal power of the gastric juice *in vivo* is considerably modified by dilution with fluids, absorption by food and neutralization by saline substances. Their experiments demonstrated the complete inefficiency of the gastric juice.

Carnière in 1901 found that artificial gastric juice mixed *in vitro* at 37° C with three to twenty four hour cultures of tubercle bacilli or in milk particles or food containing the bacilli, remained without action on them if the contact did not last at least twelve hours. After twelve hours the food was still tuberculogenic, the bacilli being only attenuated not killed. He took gastric juice from a healthy man added the same infected particles to it for twelve hours at 37° C. with the result that the virulence of the bacilli was attenuated.

Arling in 1902 performed 3 series of experiments on 30 animals (2 calves, 13 dogs, 1 sheep, 11 rabbits and 3 guinea pigs). In his first series he introduced human tubercle bacilli from a young culture by injecting them into the stomach through a fistula or inoculating them into the mucosa of the

organs of 7 animals. The experiments lasted from two to two and a half months and were terminated most often by the sacrifice of the subject more rarely by death. In this series Arloing increased the acidity of the gastric juice introduced alkaline solution into the stomach, ligated 5 or 6 arteries along the greater curvature from cardia to pylorus produced mechanical ulcerations of the mucosa with the electric needle and also an ulceration of the mucosa by the injection of an emetic before introducing the bacilli. He was unable to produce a tuberculous gastric ulcer in a single instance.

In his second series he utilized the intra-vascular method of injecting the tubercle bacilli using 1 calf 2 dogs and a rabbit. Gastric ulcers resulted in all of the animals but they were not definitely tuberculous. He was able to produce 2 tuberculous duodenal ulcers in 1 of the dogs. All of the animals in this series showed polyvisceral miliary lesions.

In his third series he introduced human bacilli in all cases by interstitial inoculation of the stomachs of 1 calf 1 sheep 4 dogs 10 rabbits and 3 guinea pigs. In the stomach of the sheep he found a tuberculous mass filled with tubercle bacilli at the point of injection. In 1 of the dogs he produced a typical tuberculous gastric ulcer with tubercle bacilli in its subjacent tissue. He was able to produce the types of tuberculous ulcerations found in man twice in 30 animals once in the stomach and once in the duodenum both times in dogs. The first time injection of the bacilli into the blood stream produced tuberculous ulcers of the duodenum and the second time injection into the wall of the stomach produced a tuberculous gastric ulcer.

Various theories have been advanced regarding the relative immunity of the stomach to tuberculosis. Some of these are as follows.

Duerck believed that the stomach is protected fairly well in normal persons by the strong acidity of its juice but that tubercle bacilli are not killed by this strong acid as is proved by the prevalence of intestinal tuberculosis and by many experiments.

Virchow ascribed the rarity of gastric

tuberculosis to the sparsity of the lymphatic supply of the stomach wall. Klebs ascribes its rarity to the sparsity and deep-seated location of the lymph follicles. Kanrow states that the main reason is not only the sparsity and the deep location of the lymph follicles but an intact condition of the epithelium and the relatively short stay of the ingesta in the stomach. Struppeler also believes that the intact epithelium acts as a protection against tubercle bacilli although he admits that they may attack the lymph follicles without injuring the epithelium. In Simmonds' opinion the normally secreting mucosa plays an important rôle.

Other organs are known to be relatively immune to tuberculosis the thyroid, salivary glands œsophagus, pancreas gall bladder ovary uterus, and heart.

Arloing mentioned the resistance of muscle tissue to tuberculosis. Probably such resistance accounts for the relative immunity of the uterus and heart, muscle being the predominating tissue in both.

#### CLASSIFICATION OF CASES

In order to draw correct conclusions from the cases that have been reported in the literature it is necessary to make a classification from a critical standpoint. For convenience the cases are grouped under four classes (1) positive (2) probable (3) doubtful and (4) rejected. The qualifications for each class are as follows.

1 *Positive* All cases that contain an histologic picture of tuberculosis plus the presence of the bacillus of tuberculosis in the depths of the lesion or the presence of the specific bacillus in the depths of an indefinite histologic lesion.

2 *Probable* All cases that possess an histologic picture of tuberculosis.

3 *Doubtful* All cases with a good gross description of tuberculosis or a good gross description plus a poor histologic description.

4 *Rejected* All cases that cannot meet the qualifications of the three preceding classes such as those regarding which is given a clinical diagnosis only a poor gross description, or a poor gross and microscopic description, cases in which the tubercle

bacillus was present on the surface of the lesion unaccompanied by a positive histologic picture cases regarding which the authors state the nature of the condition without substantiating their claims the false type of tuberculous pyloric stenosis etc.

## CLASSIFICATION OF CASES

Author	Positive	Probable	Doubtful	Rejected	Author	Positive	Probable	Doubtful	Rejected
Alessandri		1			Hamilton		3		
Alexander	1				Hanau			1	
Andral				2	Hattute			1	
Anger			1		Hebb		1		
Arloing			1		Hecke				2
Barbacci		1			Herczel		1		
Barchausch	1	1			Holt		3	2	
Barkhausen				1	Holzmänn	1	3		
Barlow			1		Jacobs				1
Baron				1	Kanawo		1		
Barth		1			Keen			1	
Batsère		1			Klebs			1	
Beaules		1			Kuehl	2	5		7
Bednar					Kundrat			2	
Bencke			1		Labadie Lagrave				1
Benker			1		Lancereaux				1
Bignon			1		Lange			1	
Blas	1	3			Lava		1		
Blumer	1				Letrov		1		
Borst	1				Letulle	1			
Brechemin		1			Leven				1
Breuer				1	Lipscher		1		
Brens		1			Lister		2	3	
Cazin			1		Litten		1		
Chailar and Nové-Josserand	1				Lorey			1	
Chevassu				1	Louis				1
Chiari		1			Lyle		1		
Chvostek			4		Marguarucci		1		
Clairmont				2	Mathieu		1		
Claude	1				Mathieu and Rémond	1			
Clayton and Wilkinson	1				Mayo-Robson and Moynihan			1	
Coats	1				Melchior		6		
Cone	1				Merry				1
Curchmann		1			Mommsen and Mouriquand				1
Czerny		1			Mueller				5
Da Costa			1		Musser	1			
Danwe			1		Naah			1	
De Vecchi	1				Nordmann	1			
Devic				1	Oppolzer			1	
Dewey	1				Papavolpe			1	
Docq		1			Patel				1
Duguet			1		Patella				3
Durante		2			Paulicky			1	
Ellis	2				Petruschky				2
Eppinger		2			Pitt				1
Ferrari				1	Plambeck				3
Fischer (Erwin)			1		Pozzi			1	
Fischer Defoy		1			Przewoski	5			
Fox			1		Quénu				1
Frerichs		6			Reinhold	1			
Frommer				2	Rémon and Verliac	1			
Fujii			1		Ricard			1	1
Gallard			1		Ricard and Chevrier				2
Gelpke		1			Rillet and Barthez				21
Glaubits	1	46			Roger				1
Godart Danheux				2	Rosset		1		
Gossmann		3		1	Ruge	1			
Habenbon	1				Satterthwaite				2
					Schede	1			
					Schlesinger		1		
					Serafini	1			
					Slagg		1		
					Simmonds	1	11		
					Steiner and Neureutter				4
					Stelter				5
					Still	2	1	2	
					Sokolowski	1			
					Struppler				1
					Talamon		1		

Author	Paper	Probable	Doubtful	Rejected	Lymph glands involved	
Thorel	3				Negative or not indicated	26
Tischoff						3
Tripler						49
Vallas						
Van Wart					Peritoneum involved	
Von Tappeiner					Negative or not indicated	37
Weinberg						49
Wiederhofer						
Wilms					Liver involved	
Winternitz					Negative or not indicated	39
Perponal						49
Total		49	8	59	80	

## STATISTICS COMPILED FROM POSITIVE CASES

Adults	33	
Children	5	
Not indicated	4	
	49	
		49
Males	24	
Females	14	
Not indicated	1	
	49	
		49
		3
		5
		4

## TYPES OF LESIONS

Single ulcer	14	
Single ulcer and miliary tubercles		
Single ulcer and nodules		
Single ulcer and carcinoma		
Multiple ulcers	9	
Multiple ulcers and miliary tubercles	3	
Multiple ulcers and carcinoma		
Miliary tubercles	3	
Solitary tubercle		
Solitary tubercle and carcinoma		
Tumors or nodules		
Lymphangitis		
	49	
		8

Total ulcer cases, 40 out of 49 (81.6 per cent)

## LOCATION OF ULCER OR ULCERS IN ORDER OF FREQUENCY

Lesser curvature		
Greater curvature	6	
Pylorus	5	
Posterior all	3	
General distribution		
Cardi		
Not indicated	3	
	49	
		8

OTHER ORGANS INVOLVED FINDINGS NEGATIVE,  
OR CONDITION NOT INDICATED

Lungs involved	34	
Lungs not involved	5	
Not indicated		
	49	
		8
		5
		3
		3
		3
		67
		95

I testicles involved  
I testicles not involved  
Not indicated

Total ulcer cases, 95 out of 118 (80.5 per cent)

## LOCATION OF ULCER &amp; ULCERS IN ORDER OF FREQUENCY

Pylorus		
General distribution		
Lesser curvature		
Posterior wall		
Cardia		
Greater curvature		
Anterior all		
Not indicated		

OTHER ORGANS INVOLVED FINDINGS NEGATIVE  
OR CONDITION NOT INDICATED

Lungs involved	103
Lungs not involved	2
Not indicated	14
	118
Intestines involved	82
Intestines not involved	6
Not indicated	30
	118
Lymph glands involved	51
Negative or not indicated	67
	118
Liver involved	41
Negative or not indicated	77
	118
Kidneys, one or both involved	34
Negative or not indicated	84
	118
Spleen involved	25
Negative or not indicated	93
	118
Peritoneum involved	19
Negative or not indicated	99
	118
Esophagus involved	4
Negative or not indicated	14
	118
Tuberculosis and carcinoma of the stomach	2
Cases with perforation	5
Cases clinically diagnosed carcinoma	3
Cases thought by author to be primary	2

The tuberculous process has been considered primary in the stomach 4 times (Lava Ruge Fischer Defoy and Van Wart) Lava's patient had tuberculosis of the intestines and lymphatic glands in the pyloric region accompanied by an acute diffuse sero fibrinous peritonitis and a chronic peritonitis Ruge's patient had tuberculosis of the pleura intestine peritoneum right kidney and of the omental para aortic and inguinal lymphatic glands In the case described by Fischer Defoy there was tuberculosis of the lungs intestines and lymphatic glands of the lesser curvature of the stomach and in the region of the liver According

to the author the older process was in the stomach and intestinal tract but there was no exact proof that it was primary in the intestine. Van Wart was unable to demonstrate tuberculosis in any other part of the body although the patient had chronic peritonitis pleuritis and pericarditis It was impossible to state whether the lesion was primary in the stomach but there is no definite evidence to the contrary

The cases of the first three authors cited should not be classified as primarily gastric The only case which could be considered primary in the stomach is that of Van Wart who stated The autopsy revealed no other definite tuberculous lesion but the nature of the process giving rise to the peritonitis pleuritis and pericarditis must be considered

No case of tuberculosis should be considered primary in the stomach unless a thorough search does not show any evidence of the disease in any other part of the body

## CASE REPORT

F P male age 42 years brick layer married 11 years. One child who died at the age of one year from meningitis. Patient had had no previous diseases of note. Chief complaint stomach trouble. Operated on six months previously elsewhere incision closed diagnosis of inoperable carcinoma of stomach. *Clinical history* The trouble began two years previously with a feeling of heaviness in the epigastrium which came on from one half to two hours after meals. Six months later he began to have attacks of vomiting every two or three days from two to three hours after meals. Nine months previous to coming for examination he ceased vomiting for two months but there was no cessation of the epigastric distress. Six months previously there was recurrence of vomiting almost daily about one half an hour after meals. The patient lost weight rapidly. Six months prior to coming to the Clinic an exploratory operation was done after which there was some improvement for five months. For the past three weeks regurgitation occurred as soon as food was taken. The patient could retain egg nog. He never had severe pain or sour stomach. Always felt hungry. *Physical examination* Nothing of note except a mass in the right side of the upper abdomen. *Pre-operative laboratory findings* Hemoglobin 70 per cent, erythrocytes 4,760,000. Test meal total acidity 12 all combined food remnants; on a basis of 4 filtrate 1.50 cubic centimeters Oppler Boas; on a basis of 4. *Roenigkologic report* carcinoma of stomach operable. *Clinical diagnosis* carcinoma of the stomach. *Operation* Polya resection about one-

third of stomach removed high midline incision (E. S. Judd). Tumor of stomach near pylorus marked asperm but stomach not dilated.

*Post operative laboratory and gross macroscopic.* Pyloric third of stomach containing three yellowish-brown ulcers with ragged edges and dirty rough bases on mucous surface (Figs 1 and 2). The larger ulcer extends from a point 1.5 cm from the pyloric ring upward on the greater curvature for 7 cm. It is 4 cm in width. The two smaller ulcers are 1 cm in diameter. One is situated 5 cm from the pyloric ring and 7 cm from the large ulcer the other is 3 cm from the pyloric ring and 3 cm from the large ulcer.

*Microscopic.* Sections from all of the ulcers show typical tubercles with characteristic giant cells extending down to the musculature (Figs 3 and 4). Paraffin sections stained by the Ziehl-Neelsen method show a few scattered tubercle bacilli in the depths of the ulcers (Fig 5). A thorough search for spirochetes was made but the findings were negative. A few of the lymphatic glands attached to the resected portion of the stomach are slightly enlarged and on gross section are of a yellowish-brown color. Microscopically they show typical tubercles and giant cells. These glands apparently are in the precancerous stage.

Three sputum examinations were all negative to acid-fast bacilli. Von Pirquet test negative. Complete blood count one day after operation Hemoglobin 8 per cent, erythrocytes 5,440,000 leucocytes 23,400 differential total number 300, polymorphonuclear neutrophils 88 per cent small lymphocytes 10 per cent large lymphocytes 7 per cent basophiles 0.3 per cent. White blood count three days after operation leucocytes 25,800 differential, total number 300 polymorphonuclear neutrophils 90.3 per cent small lymphocytes 6.7 per cent large lymphocytes 3 per cent. White blood count six days after operation leucocytes 9,200 differential total number 300 polymorphonuclear neutrophils 83.7 per cent small lymphocytes 10.7 per cent large lymphocytes 5.3 per cent eosinophiles 0.3.

*Wassermann test six days after operation.* Total inhibition.

Patient died 11 days after operation. *Clinical cause of death.* Pneumonia.

*Necropsy (one and one-half hours after death).* An extremely emaciated white man about middle age 5 feet 8 inches in height and weighing about 90 pounds. Findings negative except for an upper midline abdominal incision 14 centimeters long with edges in good apposition. On section of the thorax firm pleural adhesions at both apices and a recent fibrinous pleurisy over the lower lobe of the right lung were encountered. At the apex of the left lung was an area of old tuberculosis measuring 5 by 7 by 5 centimeters and characterized by fibrosis, dry and caseous tubercles. Throughout the remainder of this lung, as well as the lower lobe of the right lung were scat-

tered areas from milium size to 2 centimeters in diameter showing various stages of the tuberculous process. The peribronchial lymph glands were enlarged. The heart was small, weighing only 2 gm. Except for apparent myocardial degeneration, it was normal. About one-third of the pyloric end of the stomach had been resected and there was a clean anastomosis between the remainder and a loop of the jejunum. In the gastrocolic omentum were several hard nodules about the size of a pea, probably tuberculous glands. The retroperitoneal glands in the region of the stomach were enlarged. The intestines were absolutely free from tuberculosis. The liver showed a fairly marked fatty change. In the remainder of the abdominal viscera, the pelvic viscera, and the genitalia, there was nothing of note.

*Anatomic diagnosis.* Recent tuberculosis of the lower lobes of both lungs with an old tuberculous process in the left upper lobe. An acute fibrinous pleurisy of the right side and an old adhesive pleurisy of the left. Myocardial degeneration, fatty changes in the liver and tuberculous lymphadenitis.

*Microscopic examination.* In the apex of the left lung was an old tuberculous process characterized by a marked fibrosis in addition to the typical picture of tuberculosis (Fig. 6). In sections from the depths of the lower lobes of the lungs stained by the Ziehl-Neelsen method numerous tubercle bacilli were found (Fig. 8). Sections from the peribronchial lymph glands showed typical tuberculosis not yet broken down. Sections from the remainder of the stomach showed no tuberculosis. Sections from the lymph glands in the gastrocolic omentum showed tuberculosis. The liver showed a marked fatty change. In the remainder of the organs there was nothing of significance. In a smear from a freshly cut surface of the lower lobe of the left lung stained by the Ziehl-Neelsen method were numerous tubercle bacilli (Fig. 7).

A Wassermann test from the blood at necropsy showed a total inhibition.

#### SUMMARY AND CONCLUSIONS RELATIVE TO THE CASE REPORT

1. The clinical history suggested a gastric ulcer or carcinoma.
2. There was no sign or symptom in the clinical history suggesting disease of the chest so completely did the gastric symptoms predominate.
3. The failure to detect the lesion in the apex of the left lung by the physical examination was probably due to the absence of cavity formation.
4. Three sputum examinations following the operation failed to throw any light on the pulmonary condition.
5. In all probability the source of infection in this case was the old tuberculous lesion in the upper lobe of the left lung.
6. The tuberculosis of the peribronchial lymphatic glands and the lymphatic glands adjacent to the

stomach were probably secondary to tuberculosis of the upper lobe of the left lung and the stomach respectively

7 If the Wassermann test is infallible in the presence of advanced tuberculosis this patient had syphilis but whether it was infallible or not the outstanding fact is that the patient had gastric and pulmonary tuberculosis as was proved by a definite histologic picture and the finding of the bacillus of tuberculosis in the depths of the lesions.

# GENERAL CONCLUSIONS

1 Little was known of gastric tuberculosis before the middle of the nineteenth century

2 Gastric tuberculous lesions have practically the same gross and microscopic appearance as tuberculous lesions of the intestines

3 A specific reason for the relative immunity of the stomach to tuberculosis still remains unknown.

4 The gastric juice appears to have a very slight effect on the tubercle bacillus unless the contact extends over a period of at least twelve hours

5 It is possible to produce gastric tuberculosis experimentally

6 The exact mode of infection is often difficult to determine

7 The theory that gastric tuberculosis is always secondary to intestinal tuberculosis has been disproved.

8 About half of the cases reported as gastric tuberculosis should be classified as doubtful or rejected

9 Adults are affected more often than children the ratio being about 3 to 1

10 Males are affected more often than females, the ratio being about 2 to 1

11 Ulcer is the predominating lesion in the positive and probable cases constituting 81.6 per cent of the former and 80.5 per cent of the latter

12 In the positive cases the lesser curvature is the most frequent site of the ulcer or ulcers the pylorus leading in the probable cases and in a combination of the positive and probable cases

13 In tuberculosis of other organs associated with gastric tuberculosis the lungs take the lead closely followed by the intestines

14 No case of tuberculosis of the stomach has been absolutely proved to be primary in the stomach

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## STENOSIS OF GASTRO-ENTEROSTOMY STOMA, SIMULATING RECURRENCE OF CARCINOMA OF THE STOMACH

REPORT OF TWO CASES<sup>1</sup>

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**R**ADICAL cures following resection of the stomach for carcinoma are by no means very frequent. Many cases begin to complain about recurrence of their pre-operative symptoms (vomiting loss of weight etc.) in a comparatively short time after the original operation. Therefore we are apt to suspect a recurrence of the carcinoma in these cases and consequently advise against any further operative interference. And yet not all cases of this group are really suffering from a recurrence of the original tumor. The following two cases are presented as evidence that all the classical symptoms of recurrence of cancer of the stomach can be simulated by mechanical causes not due to recurrence or metastasis of the original tumor.

**CASE 1** L. S. age 36 admitted August 18 1915 discharged September 21 1915 Diagnosis carcinoma of the stomach.

**History** The patient has lost about 20 pounds in the last six months otherwise she claims to have been perfectly well up to a week ago. In the last week she vomited a great deal and complained of weakness and pains in the epigastrium.

Examination showed a large nodular mass, extending across the epigastrium, slightly movable. It was thought possible that this mass might represent a tumor of the transverse colon. A barium enema given to this patient on August 21 1915 showed a defect in the middle transverse colon. By request of the X-ray Department, another barium enema was given and this second enema failed to reveal any defect in the transverse colon. This defect then only represented a spastic condition of the transverse colon. The X-ray examination of the stomach showed a defect in the pyloric region, affecting the greater curvature and adjacent portion of the stomach, the passage through the pylorus was obstructed. Six hours after injection a large residue was present. Diagnosis Neoplasm of the pyloric end of the stomach.

Test meals showed a large residue no free acid total acidity 18 no blood.

The patient was in such a weak condition that a blood transfusion was deemed advisable before operation. There were given 400 cubic centimeters of blood with the Kush apparatus.

**Operation August 28** Partial gastrectomy hutton gastrojejunostomy for carcinoma of the pyloric end of the stomach (Dr Lewisoohn). The abdomen was opened through an upper median incision. A large tumor involving the pyloric end of the stomach was found. The tumor was freely movable. No metastases were found. Typical resection of the stomach after the second Billroth method. Posterior retrocolic hutton gastrojejunostomy. Specimen. The tumor of the pylorus is the size of an orange the mucosa is ulcerated, surrounded by raised margins. There is a sufficient part of normal stomach and duodenum on both sides of the specimen. Microscopical diagnosis adenocarcinoma.

Recovery uneventful patient left the hospital on September 21 1915.

Patient re-admitted to the hospital on January 17 1916 discharged February 19 1916. An X-ray examination taken a few days before re-admission showed that the Murphy hutton was still in place. Considerable gastritis and marked delay in the emptying of the stomach. The patient has been perfectly well for two months following the primary operation. In the last two months she is complaining of incessant vomiting marked weakness and loss of weight. She has lost 10 pounds since the onset of her symptoms.

**January 22 1916** Operation for inefficiency of gastro-enterostomy stoma (Dr Lewisoohn). The abdomen was opened through an upper median incision. The exploration revealed the hutton at the site of the anastomosis. The hutton had not turned around on its axis but was still in exactly the same position where it had been put at the previous operation. The lumen of the hutton was still connecting the stomach with the jejunum. One hard gland in the gastroduodenal omentum was removed for diagnosis otherwise there were no signs of any recurrence of the carcinomatous growth. A moderate pressure was exerted to force the hutton through into the jejunum. This was not feasible. Therefore the gastro-enterostomy was reopened, the hutton removed, and a suture gastro-enterostomy was done at the site of the previous stoma. The wound was closed with through and-through chromic sutures and an additional silk suture for the skin. Microscopical examination of the lymph nodes showed a metastatic adenocarcinoma with extensive calcification.

The patient made an uneventful recovery except for a rather profuse diarrhoea following the second operation.

**Postoperative course** This patient has gained about 10 pounds since the operation. She looks

and feels perfectly well. There are no signs of recurrence at the present time (August 1917) Weight 55 pounds

CASE 2. M. A. age 35 admitted November 20 1915 discharged December 3 1915. Diagnosis carcinoma of the stomach

*History* The patient had been suffering from burning sensation in her stomach for two months no vomiting. She has lost 5 pounds in weight in the last year and complains of progressive weakness

Examination showed a peculiar nodular mass somewhat tender in the epigastrium.

The test meals showed a trace of blood, lactic acid positive free and total acidity 40

The X-ray examination showed a defect in the lesser curvature and slight delay in the motility of the stomach. Diagnosis carcinoma of the stomach

*Operation, December 1915* Partial gastrectomy and retrocolic gastro-enterostomy for carcinoma of the stomach (Dr. A. Berg). The exploration showed a hard infiltrating mass, the size of a large orange obviously a carcinoma which was found to involve a large part of the stomach, chiefly at the lesser curvature. Several enlarged glands were found in the mesocolon. A typical resection of the stomach was performed following the second Billroth method. Upon examining the specimen, it was found necessary to remove another inch of the stomach wall, as the previous incision had been made too close to the tumor. After the stomach and duodenal end had been closed in the typical way a posterior retrocolic button gastrojejunostomy was performed and the abdomen was closed with through-and-through sutures. The specimen showed a hard circular ulcerating carcinoma, involving chiefly the lesser curvature, size 4 x 4 inches. The microscopic examination showed an adenocarcinoma with involvement of the lymph nodes. The small portion of the stomach subsequently removed does not show any cancerous growth

The patient made an uneventful recovery and was discharged on December 30 1915

Patient re-admitted to the hospital April 1 1916 discharged May 1 1916. The patient has suffered from pain in the epigastrium for the last two months. She has vomited repeatedly and has required lavages during the last three weeks. She is extremely emaciated. The X-ray examination shows a marked obstruction of the gastrojejunostomy opening with retention of the barium meal in the stomach. Diagnosis stenosis of gastro-enterostomy stoma

*Operation (Dr. Berg) April 5* The abdomen was opened along the line of old scar the adhesions of omentum to abdominal wall were divided. A loop of jejunum about eighteen inches from the duodenum was tightly adherent to the abdomen. This adhesion was divided and the raw area of the jejunum was covered with peritoneum. There was no dilatation of the gut above this adhesion. The

gastro-enterostomy was very small and very difficult to find. The stomach was adherent everywhere. The lesser sac was obliterated. An adhesion between the stomach and liver was divided. Because of the obliteration of the lesser sac, a Roux Y shaped anastomosis was necessary. There were no apparent metastases or recurrences present. The jejunum was divided about 10 inches from the duodenum. The proximal end was united to the jejunum with end-to-side button anastomosis. The distal end was closed with an inverted layer of chromic and two pursestrings of Pagenstecher. An antecolic side-to-side suture gastrojejunostomy united the stomach and the distal end of the jejunum. After completion of the operation, the stomach readily admitted two fingers. The abdominal incision was then closed with through-and-through silk sutures

The patient made an uneventful recovery with the exception of a rather marked diarrhoea, which lasted for a few weeks and yielded to treatment.

The patient left the hospital on May 11 1916. *Postoperative course* This patient has done remarkably well since the second operation. When she left the hospital, she weighed 68 pounds. She has gained weight rapidly since, and on November 26 1916 she weighed 31½ pounds. She looks perfectly well and has no symptoms of distress or vomiting. She is apparently in perfect health at the present time (August 1917)

The reason for reporting these two cases is the fact above mentioned that the classical symptoms of a recurrence were simulated by a simple stenosis of the stomach. I have not been able to find a similar observation in the surgical literature. None of the textbooks on cancer of the stomach seems to consider the possibility of such an occurrence

The cause of the stenosis is not quite evident. To be sure the Murphy button was still in place in the first case at the time of the relaparotomy. However the button had not turned around on its axis and the lumen between the stomach and jejunum was unobstructed. It cannot readily be explained why the button which had remained in its original position should have caused obstruction.

In the second case the button had passed two weeks after the original operation. It is generally assumed that gastro-enterostomy stomas with the aid of a Murphy button, do not contract especially when the pylorus is permanently closed by resection and yet this opening 4 months after the primary operation hardly admitted a lead pencil

Only a careful study of these cases greatly aided by the X ray department prevented us from labeling the cases as inoperable recurrent cancers. Without the second operation these patients certainly would have died in a short time from inanition the possibility

of a stenosis of the gastro-enterostomy stoma simulating recurrence of the cancerous growth should certainly be considered in all cases of this group. A small percentage might thus be saved by a comparatively simple operation.

## STERILIZATION AND CLOSURE OF SUPPURATING FRACTURES

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**D**URING the past year it has been shown in this hospital that recent fractures can be sterilized and closed (1).

It was important to ascertain whether the same method could be applied to older cases in hospitals removed from the battle field and for this purpose old and highly infected fractures were removed from the trains bound for Paris at a station situated close to our hospital. The patients reached the hospital a few hours earlier than they would have reached the Paris hospitals. But this anticipation of a few hours was negligible since 2 to 46 days and even 8 months had elapsed since the injury.

A great many fractures of the long bones remain fistulous. Probably 50 per cent of fractures of the thigh still suppurate after ten months treatment. This estimate of the number of osseous lesions which remain fistulous after long deferred treatment may appear excessive to surgeons primarily concerned with industrial traumatism. But unfortunately in the actual conditions of war surgery i. e. fractures of the long bones produced by bursting shells our estimate falls short of the reality.

After four months of experimentation devoted to regulating the details of this special application of Carrel's method we are in a position to affirm that fractures in full process of suppuration can be sterilized and closed. The technique comprises the following points: (a) preliminary disinfection (b) operative treatment, (c) sterilization and (d) closing of the focus of fracture.

### PRELIMINARY DISINFECTION

In nearly all instances the patients had received surgical treatment a few hours after injury in a hospital near the front. At first sight this treatment appears either complete or incomplete. In some cases we are confronted with a widely exposed fracture in others with a badly cleansed cavity which communicates with the exterior only by means of one or more inadequate openings. In the latter case one is tempted to perform an immediate operation and this procedure has often been followed in the base hospitals. But this should be absolutely prohibited for an operation conducted under these conditions is followed by a marked rise in temperature and sometimes by septicæmia and death.

Before an operation is attempted infection must be reduced as much as possible. This is accomplished by discontinuous flushing with Dakin's solution. If it is impossible to introduce tubes into the focus careful incisions may be resorted to but the bones should not be handled. These incisions do not expose the patient to the grave complications which ordinarily follow osseous operations performed in an infected focus. This preliminary disinfection must be done in all cases whether the previous operation has been well or badly conducted. An exception may be made in the case of very old fistulous fractures which show no inflammatory reaction.

The first process must be carried out by an exact observance of the principles of Carrel's method (2) and of the details of its applica-

tion. The progress of disinfection should be followed on the bacteriological curve, for it is imperative that one should be able to visualize at a glance the modifications in the number of bacteria. Every other day after the flushing has been suspended for two hours films are made of secretions from the wound taken from such parts as are apparently most highly infected. The bacteria of three microscopic fields are counted on this preparation and the average result of the observations is registered on the curve. The curves thus obtained are different from the sterilization curves of fresh fractures. The latter at the outset, show no or very few bacteria in films of their secretions and the bacteria appear in large quantities only after twenty four or thirty six hours. They increase in number for some time after which a rapid and regular diminution occurs. This is illustrated by the following experiment.

**CASE** Recent comminuted bullet fracture of the femur. Immediate removal of the splinter of bone rapid sterilization. Suture with horsehair on the fourteenth day.

G M 2042 wounded J ly 1 916 at 1 30 p m entered Hospital 2 six hours later

**Examination.** Small opening in the center of the antero-external region of the left thigh. No outlet. Abnormal mobility due to a fracture of the center of the femoral diaphysis. Moderate inflammation. The roentgenogram shows a highly splintered fracture, with a bullet in the center (Fig 1).

**Operation.** Ether anesthesia resection of the edges of the cutaneous and aponeurotic openings. Wide incision ablation of a small number of free splinters preservation of several adherent splinters.

Flushing every two hours with Dakin's solution by means of four tubes. Continuous extension.

As is usual in recent wounds, the first examination failed to reveal any bacteria (Fig 3). Two days later one bacterium was found in every ten microscopic fields. The maximum (twenty bacteria per field) was reached on the ninth day. On the thirteenth day the wound was sterile. On the fourteenth day the wound was sutured with horsehair and without drainage.

The two roentgenograms taken at the beginning and end of the treatment (Figs 1 and 2 respectively) show to what extent it was possible to reduce the fracture after its reunion.

The bacteriological curves observed in the case of old fractures are usually very different from the one we have just examined. In these cases, the beginning of the curve in

dicates the presence of an infinite number of bacteria, except where a dry scab makes it impossible to obtain a film of the secretions. On the other hand the diminution in the number of bacteria takes place more slowly than in the case of recent fractures, and is accompanied by oscillations which may last for some time as in the following case.

**CASE** Old infected shell fractures of the os crum. Slow preliminary disinfection. Hollowing out of the site of fracture. Sterilization. Closing of wound over an adipose graft.

P B age 34 wounded September 17 1916. Operation by incision and extraction of splinters in a front-line ambulance thirty hours later. Entered Hospital 21 October 5 eighteen days after being wounded.

**Examination.** In the sacral region was a large horizontal anfractuosa wound, 3 by 6 centimeters, communicating (a) by means of a submuscular sinus with a small wound in the left buttock, and (b) with the sacral fracture. The entire visible portion of the wound was covered with a dry scab produced by the local application of phenol. Lymphangitis. Temperature 37.6° C. General condition satisfactory. Films showed twenty to forty bacteria per field.

Preliminary disinfection by flushing every two hours with Dakin's solution was immediately started. The curve (Fig 4) shows that the films made from the dry scab of the wound contained only a small number of bacteria. Not until the third day did the bacteria become innumerable. After a period of oscillation the curve appeared from October 2 to 20 to tend toward sterilization. But this was followed by a series of fluctuations of five to twenty bacteria showing the presence in the wound of foreign septic bodies (sequestra fragments of clothing etc.). Under these conditions intervention became necessary.

November 2 incision of the sinus. Opening of the site of osteitis which was seen to contain six small sequestra and to communicate with the sacral canal. All the suspected osseous tissue was resected with the gouge-forceps (*pince-gouge*). Beneath the left sacrolumbar muscles muscular detachment was found. This was opened and the wall excised. All the visible necrotic tissue was carefully removed from the wound (Fig 5).

Sterilization by means of flushing was next resumed. The day after the operation, the temperature rose to 39° C. and the number of bacteria increased. The temperature fell rapidly and on November 18 six days after the operation, the wound was sterile.

For several days a pulmonary complication made it impossible to close the wound. Finally on December 15 after a short reoperation followed by a return to the sterile condition, the wound was filled up by means of an autoplasty (Fig 6) after an

adipose graft in the focus of the fracture of the sacrum had been effected. The graft was taken from the left buttock.

On the sixth day as a result of traction of the flaps three of the stitches were cut. The adipose graft in the wound was living and was rapidly becoming covered with fine granulations and later with epidermis.

This observation of a highly infected fracture of the sacrum the sterilization of which proceeded exceptionally slowly gives an exact idea of the method followed. It will be seen that the preliminary disinfection was patiently pursued for as long a time as the bacteriological curve continued to decline. As soon as a plateau appeared in the chart curve surgical intervention was seen to be necessary. When this had been performed, the course of sterilization continued in a normal manner.

We have said that it was not always necessary to have recourse to surgical intervention in order to secure the sterilization of an old fracture. This is explained by the fact that the operation performed at a first line ambulance may have been sufficient. Case 3 is an example of this type.

**CASE 3.** Infected fracture of the thigh nine days old. Sterilization attained on the twelfth day. Closure on the seventeenth day without operation.

L. J. 89025 wounded October 11, 1916 operated upon the following day in an ambulance on the Somme. October 20 entered Hospital 21.

**Examination.** Fracture of the middle of the left thigh bone. Two wide wounds led to the site of fracture. Their long axis was longitudinal. The outer wound measured 12 by 6 centimeters. The inner had similar dimensions (Fig. 7). Abundant supuration pyocyanic. Extensive inflammation of the limb. Patient looked tired. Films showed forty to sixty bacteria per field.

Figure 9 shows a splintered fracture with fissures which descended very far down and extended almost to the top of the limb. Extensive loss of substance over an area of 8 centimeters. However as the fragments came in contact with one another the continuity of the osseous layer was uninterrupted.

Flushing every two hours with Dakin's solution. Exploration conducted at the time that the tubes were inserted showed that the upper end of the fracture was exposed and that a medullary plug was already covering the lower extremity. The roentgenogram showed that only the upper part of the fracture was being flushed. As a matter of fact the disposal of the tubes was good, for sterilization was obtained in twelve days (Fig. 10) and on the seventeenth day the fracture was closed.

Closure on November 6. Both wounds were closed the inner one was sewed with horsehair in one single cutaneous plane the outer in two planes over a filling of Beck's paste. Of these two planes the first or musculo-aponeurotic plane was sewed with catgut the second or cutaneous plane with horse hair (Fig. 8).

#### OPERATIVE TREATMENT IN THE FOCUS OF THE FRACTURE

It must be assumed at the outset that the appearance of a plateau in the bacteriological disinfection curve is an indication of the presence in the wound of infected foreign bodies. These may be necrotic fragments of tendon aponeurosis or bone projectiles particles of clothing etc. Of whatever nature, it is imperative that the foreign body should be removed.

When surgical treatment is applied to flat bones or epiphyses of long bones it presents no particular difficulty. With the help of a gouge-forceps or a *frase* all the compact or spongy tissue affected with osteitis or preventing extensive flushing is carefully abraded. It is necessary as far as possible to avoid opening the joints which are capable of movement, without losing sight of the fact that any part which is well exposed and thoroughly flushed will never become dangerously infected.

The surgical treatment of old fractures of the long bones on the other hand presents real technical difficulties. It does not suffice to remove the sequestra or to abrade the necrotic surfaces or even to curette all the foci of osteitis. This form of surgery which has been practiced on thousands of cases since the beginning of the war has usually resulted in failures. As a rule, when this method has been used infection sets in rapidly in the bone marrow and in the clots of blood remaining in the wound. Osteomyelitis and lamellar necrosis of the walls of the medullary canal are the ordinary consequences of this kind of surgery while opening of intra-osseous abscesses produces fresh fistulae.

In order to avoid these complications it is necessary to perform a systematic operation involving the successive consideration of the following factors: incision, periosteal callus, sequestra, splinters and bone ends.



*Incision* In preparing the patient the use of iodine should not be employed. Dakin's solution which is necessary for the further sterilization of the wound, generally produces burns on an iodized surface.

The incision need not necessarily extend beyond the fistula or the wound of the first operation. Exposure of each diaphysis is made according to definite rules, by which a maximum portion of the bone may be exposed with a minimum of risk to the adjacent organs. The operation should be conducted plane by plane, by successively detaching and utilizing each in such a manner that the haemostasis may be facilitated and the wound as a whole may contract from the surface inward. If the line followed is that of a fistula or of an infected wound it is preferable to excise all the infected and sclerous tissues and the process of elimination or sterilization will thereby be reduced. But it is important to keep account of the quantity of tissue disposed of and care must be taken that sufficient skin is kept for future closing. The consideration of this fact has often prevented us from excising the edges of the mouth of a fistula.

*Osteitis of the periosteal callus* The best method of penetrating the periosteal callus after the surrounding osteogenic membrane has been turned back is effected by careful manipulation of the rugine. With the help of roentgenograms, this uncovering must be confined to that part of the callus which is to be excised. Through the opening thus made a gouge forceps is introduced which extends the infected cavity of the periosteal callus in the direction of the bone ends which are to be explored. The extremities of the fragments must be exposed. In order to reach the end of the callus it will suffice to scoop out with a curette every part affected with osteitis.

If the fracture is recent or if the periosteum has suffered extensive destruction there is no callus. In such cases the fracture cavity can be immediately penetrated and the bone ends are consequently more easily accessible.

*Sequestra* These may be found in the muscles, focus of fracture and medullary canal. If present in the muscles they are easily removed by an incision but they

are harder to find if situated on the side opposite from which the incision is made. In such cases after making a good roentgenogram they are best reached by means of a special incision. A careful investigation should be made for sequestra which may have been projected into the medullary canals at the time of injury. Their presence constitutes one of the causes for the absence of the medullary plug observed in the course of the consolidation of fractures.

*Splinters* If the splinters are necrotic, all fragments which are not indispensable to consolidation must be removed.

*Bone ends* These are sometimes exposed at the site of fracture, and sometimes obliterated by an osseous plug. The sealing of the fragments by the medulla must be considered as a normal stage in the evolution of open fractures. This process is impeded in various ways. Sometimes, as we have seen the projection of a fragment of bone which rapidly becomes necrotic, may be the cause. In other cases the plug after formation has been destroyed by osteitis. But in the majority of cases the defect of obturation is explained by an intense infection, which has from the outset produced necrosis of the contents of the medullary canal and of its walls. In such cases the bone ends are laid bare and are seen to be exposed and bathed in the pus proceeding from the site of fracture.

All severe accidents that follow upon operation in the focus of infected fractures are invariably connected with the opening of the medullary canal. The operation sets free the bacteria and provides them with contused tissues and clots of blood favorable to their cultivation with the result that if in their vicinity there is an inadequately drained canal filled with an easily infectible marrow the immediate result will be the occurrence of severe septic accidents.

We have regularly observed the following phenomena: (a) A fracture in which the bone ends are obturated causes no postoperative reaction. (b) A fracture in which the bone ends are not occluded produces an intense reaction if the cavity of the medullary canal is not plentifully flushed by the antiseptic solution. (c) A fracture in which the non-occluded bone ends have been widely opened



Fig. 1 (at left) Roentgenogram, Case 1 showing fracture of left femur with bullet in the center

Fig. 2 Roentgenogram taken at the end of treatment in Case 1

by surgical intervention will produce no reaction

From the above facts we have drawn the following conclusions for the treatment of bone ends (1) The surface of the medullary plugs should be explored with a curette in order to ascertain that there is no communication with the subjacent medullary canal and that no sequestrum is enclosed (2) The medullary canals which have remained open should be hollowed out with a *pince gouge* in such a form as to produce a wedge shaped cavity communicating freely with the flush ing tubes

As an illustration we shall report two cases of fracture of the humerus one of which was characterized by two obturated medullary canals and the other by the fact that the bone ends remained open

CASE 4 Infected shell fracture of the upper third of the humerus. Double medullary plug

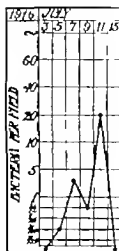


Fig. 3 Bacteriological curve of films from the wound in Case 5

Operative treatment without resulting reaction. Closure of wound

V M age 21 years Wounded October 21 1916 Operated on the following day in a first line ambulance entered Hospital 21 November 6 seventeen days after sustaining the injury

Examination Communited fracture of the surgical neck of the left humerus (Fig 11) Three wounds anterior posterior and external (Fig 12) Two drains crossed the site of fracture from front to back Abundant suppuration slight oedema of the member General condition good Films showed an innumerable number of bacteria in the anterior wound, and about thirty per field in the posterior wound.

Discontinuous flushing with Dakin's solution. The number of bacteria diminished in both wounds but the curve soon indicated a plateau at the degree of infection of twenty bacteria per field (Fig 14)

Operation December 2 Anterior incision made in the wound Removal of a sequestrum situated above two sequestra situated laterally and the necrotic end of the lower fragment The two bone ends were obturated by a medullary plug (Fig 15)

Temperature 37.9 C on the evening of the second day Rapid decline in the number of bacteria and sterilization effected twelve days later Suture with horsehair on December 21 (Fig 13)

CASE 5 Infected shell fracture of the upper third of the humerus. Absence of medullary plug at the site of the upper fragment. Operation followed by an inflammatory reaction. Closure of wound.

C D age 28 wounded October 11 operated on the same day in a first line ambulance. Entered Hospital 21 October 20 nine days after receiving injury

Examination Punctured wound in the anterior region of the left axilla At the level of the upper third of the arm there was a vertical posterior wound measuring 8 by 6 centimeters (Fig 16) The surface of this wound was covered with necrotic



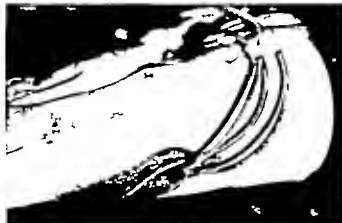


Fig 7 Wound of the thigh, Case 3



Fig 8 The same as Fig 7 closed with horsehair

## STERILIZATION OF THE FOCUS OF FRACTURE

In infected fractures of the long bones the wide opening of the non-obturator medullary canal is a factor of importance. But this detail in itself does not suffice to prevent every form of reaction. It is usually observed that the temperature reaches its maximum in the evening of the second day after

the operation. Thus there is an interval of more than twenty four hours during which the multiplication of bacteria at the surface of the new wound should be prevented as much as possible.

It was found that in the first days of sterilization the most infected parts were always the blood clots situated in the vicinity of the severed bones or of the medullary cavities. Therefore it was attempted to prevent the formation of the clots. With this object in view after having clamped and ligated all the bleeding vessels with the utmost care we arrested all oozing of blood from the bones and medulla by means of prolonged flushing with physiological salt solution at 40° C. Some times more than a quarter of an hour was needed to obtain this result, but there is no doubt but that this perfecting of the technique has



Fig 9 Roentgenogram Case 3 showing fracture of left femur with deep fissures.

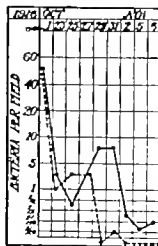
Fig 9 Bacteriological curve of films from wounds.  
—— External wound      - - - - Internal



Fig. 2. Roentgenogram (Case 4) showing comminuted fracture of the surgical neck of the left humerus.

shortened the time employed in the process of sterilization.

In a similar manner the process of disinfection during the first two days was accelerated by flushing out the wound every half hour

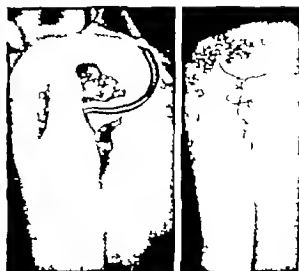


Fig. 3. (left) Anterior, posterior, and external wounds. Case 4.

Fig. 3. Wound sutured with horsehair.

during the day and every hour during the night, after which the usual flushing every two hours was resumed.

When flushing is repeated at close intervals it is important to use hypochlorite prepared electrolytically as this substance exerts only slight irritation on the skin.

The combination of these three processes—the wide opening of the medullary canals, careful hemostasis and frequent flushing with electrolytic hypochlorite—has enabled us practically to suppress all postoperative febrile reactions.

This method of procedure has also greatly

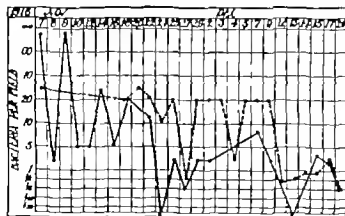


Fig. 4. Bacteriological curve of films from wound in Case 4.  
— Anterior wound — Posterior wound



Fig. 5. Combination roentgenogram and drawing of Case 4. The roentgenogram was taken after removal of sequestra and necrosed end of lower fragment of the bone. The drawing showing the operation performed. *M P* Medullary plug; *S* sequestra.

affected the course of the bacteriological curve. After our first operations on old



Fig. 8. Combination roentgenogram and drawing of Case 5 showing fracture of the humerus and operation performed. *M P* Medullary plug; *S* sequestra.

fractures the number of bacteria increased *ad infinitum* during the next few days. It will be seen by means of the accompanying charts that this bacterial increase has now become almost negligible. At all events after a varying length of time the number of



Fig. 6 (at left) Case 5. Wound of upper third of arm and in axillary region.

Fig. 17. Wound sutured.



Fig. 19. Bacteriological curve from films of the wound in Case 5.

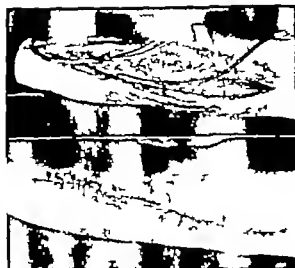


FIG. 20 (1 top): Wound of the inner surface of right leg and thigh, Case 6.

Fig. 21: Wound sutured over an adipose graft.

bacteria falls below three per field. When this stage is reached it is advisable to let several days elapse before closing the wound.

#### CLOSURE OF THE WOUND

In fresh fractures once sterilization is assured, the closing of the cavity is effected without any special difficulty. After resection of the edge of the epidermis the edges of the wound are dissected. Profuse bleeding is avoided as much as possible. Horseshoe sutures are performed. If pressure is applied to the dressing while at the same time the bone end and adherent splinters are



Fig. 21: Roentgenogram showing fracture of right fibula.

brought together the cavity produced by the fracture will be completely obliterated.

The same procedure is also successful in old fractures if the periosteal callus is not in process of formation or if the condition of the muscles makes it easy to force them back into the cavity.

In all other cases the focus of fracture can not be closed without the aid of a filling; for otherwise a cavity would be left beneath the sutures in which the secretions of the wounds would accumulate. Various kinds of filling were experimented with: Mosetig's substance, Beck's paste (Case 3), chloramine paste (Case 5), and adipose grafts (Case 2).

The results can be summed up in the following statements: Beck's paste is superior to that of Mosetig for it is easier to apply and involves no danger of intoxication. Beck's paste used under conditions with which we deal necessitates the interposition of a musculo-aponeurotic plane between the paste and the cutaneous sutures. In the case of old fractures it is hard to effect this interposition. The chloramine paste has the advantage that it can be applied directly beneath cutaneous sutures. But it falls away if as

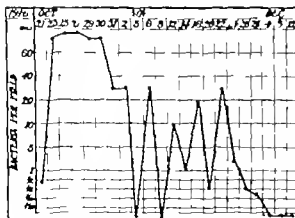


Fig. 3: Bacteriological curve of films from Case 6.



Fig. 24. Roentgenogram showing transverse fracture of tibia and fibula. Case

frequently occurs in the case of old fractures the sutures pull and gap slightly owing to the lack of tissue. The best filling seems to be an adipose graft but this procedure must be limited to cases in which the formation of the periosteal callus is well advanced and where there is no danger of pseudarthrosis. With this one limitation this method is found suitable in the majority of cases since (1) it does not require the making of a musculo-aponeurotic layer (2) the graft is always obtainable in the vicinity of the zone of operation and (3) it will keep in place even in cases where, owing to the lack of a sufficient quantity of cutaneous tissue the wound has remained partially open.

**CASE 6.** Old infected shell fracture of the tibia. Sterilization of the focus. Wound closed over an adipose graft.

J. V., age 31, wounded October 10, 1916, operated on fifty-one hours later in an ambulance on the *Somme*, entered Hospital 21 October 20 ten days after being injured.

**Examination.** The inner surface of the leg and of the right thigh showed a large muscular wound, of about 30 square centimeters in area (Fig. 20). At the lower third of the wound there was extensive loss of tibial tissue (Fig. 22). The muscles were covered with necrotic tissue. The focus of fracture contained a serous fluid as well as the broken ends of the bone which constituted an irregular cavity. Innumerable bacteria were seen on the films. On the first day the films were obtained from a part of

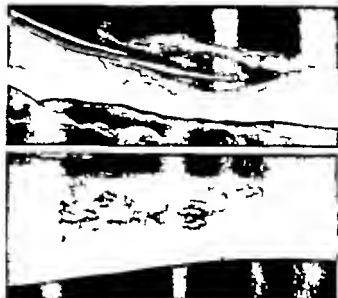


Fig. (at top) Wound of leg Case 7  
Fig. Wound closed.

the surface of the wound covered with a dry scab and contained but a few organisms.

On October 27, one week after the patient's arrival the wound was cleansed. On October 30 the number of bacteria began to diminish (Fig. 23) but from November 2 to 22 it fluctuated in the neighborhood of twenty per field. After November 22 the wound rapidly became sterile. Closure on November 30 with horsehair but the cutaneous tissues were taut and were not present in sufficient quantities around the fracture. The cavity was filled with chloramine paste and every other day sufficient paste was added to maintain the sterility of the cavity. On December 13 the tissues appeared to have become sufficiently supple again to permit of their being reunited. The site of fracture was filled with an adipose graft and the tissues were completely sutured (Fig. 22).

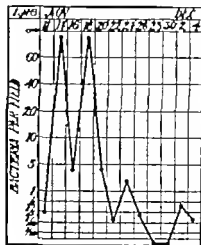


Fig. 27. Bacteriological curve of films in Case 7





Fig. 8 (left) Case 8 Roentgenogram showing fracture of femur.

Fig. 29 Case 8 Roentgenogram showing fracture of femur.

In order that the technique of applying adipose grafts may be successfully accomplished a few special precautions should be observed.

The liberation of the edges of the crater must be followed by careful hæmostasis. At this stage the horsehair stitches to be used for the suture are inserted. The center of these threads is placed along the ends of the wound in such a manner that the graft can be slipped into the cavity of the fracture without catching in them. The graft tissue is then removed from the subject himself (after both gloves and instruments have been changed) either from the buttock or the antero external



Fig. 3 (top) Case 8 Antero-internal wound of thigh.

Fig. 3 Case 8 Postero-external wound of thigh, closed.

region of the thigh. The patient should not be turned in order to remove the graft for this may involve faults of asepsis. Before sliding the grafts into the cavity the periphery of the cutaneous opening should be carefully protected by means of compresses in such a way that there is no danger of either the skin or horsehair being touched. Once the graft is in place the threads need only be drawn.

It has been seen in Case 6 how difficult it sometimes is to obtain a sufficient amount of skin to cover an old fracture. In certain cases failures result, and, after the wound has been closed as well as possible the cavity must be allowed to fill up spontaneously. In such cases it is well to preserve its sterility by filling it up every day with chloramine paste.

The following is a good example of this difficulty.

CASE 7 Open fracture of the leg caused by a horse's hoof infection. Closure of the wound a sequestrectomy operation and terilization. In sufficiency of cutaneous tissue.

J. M. age 43 wounded August 7, 1906 operated upon in both hospitals. August 8, October 8 entered Hospital fifty-one days after being injured.

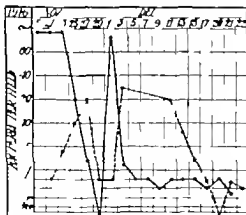


Fig. 30. Bacteriological curves from films in Case 8.

The first operation was an osteosynthesis performed with a Lambotte plate which was removed 38 days after its insertion.

**Examination** On the middle third of the leg bordering on the lower third there was a cicatrix measuring 20 centimeters in length by 0.5 centimeter in width the lower part being detached by the distance of 5 centimeters. At this spot, the surface was inflamed and suppurating. Fracture non-consolidated and painful the limb was edematous. Films taken from the tissues stained violet by an antiseptic, showed but few bacteria. The roentgenogram (Fig. 24) showed a transverse fracture of the tibia at the juncture of the middle and lower third. The fracture of the fibula was situated 2 centimeters higher. The fragments of the tibia were placed end to end. Several annular sequestra corresponding to the screws of the plate of Lambotte, could be distinctly seen in the bone ends. Disinfection with 10 per cent chloramine paste.

Rapid cicatrization, except at the level of three fistulae leading to a portion of exposed bone. The narrowness of these fistulae made it impossible to take the secretions for examination.

**Operation** On November 13 the scar and the granulations were excised. The periosteum was raginated at both ends of the bone, these being connected by means of fibrous tissue whereupon the circular orifices corresponding to the roentgenogram were disclosed. Each of these openings was surrounded by a dark bony shell, which was cylindrical and mobile. These two bone ends were hollowed out and the intermediary fibrous tissue was removed and by this means a regular drainage canal was obtained formed by the two bone segments.

Flushing every two hours with Dakin's solution (Fig. 25).

The following evening the temperature was 38° C. The bacteria, which on November 14 were infinite in number rapidly diminished (Fig. 27). The focus was sterile on November 26. Closure on December 6. The skin although taken from remote parts was unable to cover the middle portion of the wound. A section 5 centimeters in length at the site of the old fracture, remained open. The bone cavity was filled with chloramine paste. On each succeeding day after the operation the paste was renewed. Complete cicatrization twenty days after closing the wound (Fig. 26).

It is probable that in the case of very old fractures a considerable amount of difficulty would be encountered in covering the operated surfaces with healthy skin but our investigation has not yet been extended to this

point, and was confined to a case eight months old at the time when surgical intervention was applied. In this case it was found possible to procure a sufficient quantity of autoplasmic tissue for the purpose of covering the wound.

**CASE 8** Infected shell fracture of the femur eight months old. Operation Sterilization. Closure of wound thirty-six days after operation.

J. A. age 26 wounded March 13, 1916 operated on in a first-line ambulance. Transferred to Hospital 21.

**Examination** November 5. At the juncture of the middle and lower thirds of the right femur there was a large callus. The tissues showed two adherent scars: one antero-internal, the other postero-external. Each of these scars disclosed a fistula through which the denuded bone could be reached with the probe.

The roentgenograms (Figs. 28 and 29) showed a deviation of the axis of the bone. The ends of the bone were covered by periosteal callus. A side view showed that between the fragments there was a rarefaction of bone tissue corresponding to osteitis of the callus. In both the callus and the surrounding muscular parts small metallic fragments were discernible.

Both fistulae contained a large number of bacteria (Fig. 30).

**Operation** November 16. Vertical incision with excision of the walls of the antero-internal fistula. Liberation by means of the rugine of the inner side of the callus. The bony opening of the fistula was enlarged with the gouge and mallet. Next, a funnel-shaped opening was made in the callus by means of the gouge forceps until the zone of osteitis was reached which in the side view of the roentgenogram appeared as a light spot. This procedure was repeated in the case of the postero-external fistula, and by this means one single and regular bone cavity was formed terminating in healthy bone and opening widely to both sides of the thigh.

Flushing every two hours with Dakin's solution.

After December 3 the antero-internal wound (Fig. 31) rapidly became sterile. The postero-external wound was sterile on December 17.

**Closure** On December 22 the postero-external wound had become linear in shape and closed up spontaneously (Fig. 32). The antero-internal wound was finally sutured with horsehair.

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## SUCTION-BULB ACTION OF THE GALL-BLADDER

BY AXEL WERELIUS, M.D. F.A.C.S., CHICAGO

UNTIL very recent times the gall bladder was universally considered a biliary reservoir. The relative disproportion between the quantity of bile secreted, and the capacity of the gall bladder however made such a theory untenable.

F Rost in a paper on experimental work on the gall bladder enumerates the various theories advanced in regard to the function of the organ in question. Sylvius held the view that the bile production took place within the gall bladder. Orlob disproved this theory by performing cholecystectomy on dogs demonstrating that after removal of the gall bladder the bile still flowed into the duodenum.

Billard and Cavallie believed that the tenacious bile of the gall bladder in mixing with the thinner gall from the liver somewhat retarded the bile current. Kalk considered the gall-bladder mainly as a mucin producing organ. W J Mayo<sup>1</sup> advanced the theory that it took the pressure off the common duct as evidenced by the dilatation of this tube following cholecystectomy.

In operating on a gall-bladder case some time ago I noticed that the liver in its respiratory excursions produced a mechanical passive contraction and relaxation of the gall bladder. I noticed alternately a collapse of the fundus and a distention of the indented area corresponding to the respiratory movement of the liver.

This of course indicated that the intracystic pressure varied in inspiration and expiration. That such was the case was easily proved by the introduction of a tube into the gall bladder of a dog connecting it with a mercurial manometer. The accompanying charts show the variations in pressure, corresponding in time to the respiration. These alternating changes in the pressure take place in the closed as well as in the

widely opened abdomen. In order to register these pressure changes under as normal intrabdominal conditions as possible, the tube from the gall bladder can be carried through the rectum and anus and then attached to the recording apparatus. The abdomen is then completely closed.

This contraction and relaxation of the gall-bladder which undoubtedly is passive takes place only at certain intervals. The gall bladder as observed in the open abdomen, appears to be mostly of fixed dimensions. This is explained by the fact that only at certain periods is the bile ejected into the duodenum. At other times the sphincter of valve at the entrance of the duct into the bowel is closed damming back the bile into the gall bladder. Not until this reflex obstruction is done away with will the massage of the liver cause this alternate passive contraction and relaxation of the gall bladder and incidentally its suction action.

The gall-bladder and the liver-duct are arranged in exactly the same manner as the stomach tube with its bulb. Now as it is shown from the above that there takes place an alternate contraction and relaxation of the gall bladder it is reasonable to assume that the same physical phenomena occur in the bile-outlet as in the manipulated stomach tube. During inspiration there is, as shown by the above experiment, a decided increase in pressure of the gall bladder and undoubtedly a pressure in the common duct is a great deal less than in the bladder. Thus the bile is forced into the duct. As the least resistance to the flow is in the direction of the duodenum (with open valve) the added impetus given by the emptying of the gall bladder undoubtedly enhances the current in this direction.

During expiration the intracystic pressure is greatly lessened in fact it is negative, and undoubtedly the pressure in the common duct is greater than in the bladder — consequently the bile flows into the sac.

1. Die Funktionelle Bedeutung der Gallenblase. Experimentelle Untersuchungen nach Cholezystektomie. Mitt. d. Chirurg. d. Med. Chir. 3, 1905.

2. W J. Collected Papers of the Mayo Clinic.

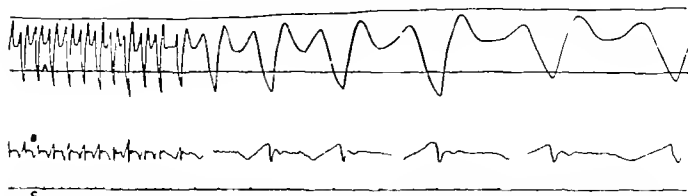


Fig 1. A Gall-bladder pressure changes—down stroke inspiration, up stroke expiration. B Respiration—up stroke, inspiration down stroke expiration. C time in second intervals. At left of chart, slow drum at right fast drum. Dog weighed 23 pounds 12 ounces. Ether anaesthesia.

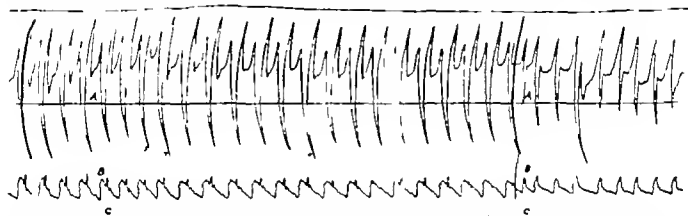


Fig 2. A Variations in gall-bladder pressure. At left of chart abdomen closed, at right abdomen open. Down stroke, inspiration, up stroke expiration. B Respiration—up stroke, inspiration down stroke expiration. C Time second intervals. Dog weighed 23 pounds 12 ounces. Ether anaesthesia.

The rapid relaxation of the bladder probably produces a certain amount of suction thus again enhancing the flow duodenum ward.

With a proved alternate increase and decrease of pressure in the gall bladder and connected in the manner that it is to the bileduct the gall bladder must by indis-

putable laws of physics act as an accelerator of the hile flow when the duodennal valve is patent.

I wish to express my appreciation to Professor P. Dryer of the Department of Physiology of the University of Illinois, who assisted by Dr. C. H. Phifer made the above pressure tracings.

END-RESULTS OF NEPHRECTOMY FOR RENAL TUBERCULOSIS<sup>1</sup>

BY WILLIAM E. LOWER, M.D., F.A.C.S. AND THOMAS P. SHUPE, M.D. (CLEVELAND, OHIO)

THE lay public as well as members of the medical profession are no longer content with operative statistics which show only the mortality rate for while a low mortality is always desirable it is no less important to know whether or not the operation has cured the patient's disease and also what postoperative complications if any have followed the operation. In other words, the success of any surgical procedure is to be determined by its *end results* no less than by its attending mortality rate.

In discussing the end results in the cases here considered, we must first determine how tuberculosis of the kidney is to be defined for if the lesion is confined to the kidney the cure is comparatively simple and positive but if the ureter and the bladder are involved also the problem and the results are vastly different.

Tuberculosis of the kidney without involvement of the ureter and bladder is comparatively rare however for in practically all cases that come to the surgeon the symptoms are referable to the bladder rather than to the kidney. For this reason disappointment often comes to both the surgeon and the patient because in those cases in which the bladder symptoms are secondary to grosser lesions of the bladder and not due to irritation from infected urine the symptoms, as a rule, are not relieved immediately and not infrequently they never disappear entirely.

Nephrectomy removes only the focus of the infection in the urinary tract. Nevertheless the removal of this large focus enables the patient to strengthen his resistance against the invading infection and thereby aids in the cure of the remaining lesions. Unfortunately the foe with which the patient has to contend is not easily subdued and the fight goes over a long period of time often ending only in defeat.

It is our purpose in this paper to consider the results of nephrectomy for the relief of renal tuberculosis as they are shown by (1)

the immediate mortality rate (2) the late mortality and (3) the persistence of the symptoms. As will be seen our postoperative results are very similar to those reported by Cabot and Crabtree in their recent paper.

1 *The immediate mortality rate.* The factors which influence the immediate mortality rate are (a) *The condition of the patient at the time of operation.* If good results are to be secured the patient must be in as good a condition as possible in order that he may withstand the shock and trauma of the operation. It is especially necessary also to secure the maximum function of the other kidney. (b) *The technique of the operation.* There is no doubt that the immediate mortality rate may be lowered by gentle rather than rough manipulation by making the incision so ample that the kidney may be delivered with but slight traction and by protecting the wound against such infection as might follow the breaking of an abscess. Since the type of anæsthesia has its influence also we use light nitrous oxide anæsthesia, adding ether only if it is necessary.

2 *The late mortality rate.* These factors—the condition of the patient and the operative technique—influence the late mortality even more than the immediate mortality. To the extent that the severity of the operation lowers the patient's resistance will convalescence be prolonged or life endangered. Rough manipulations may make it impossible for the tissues ever to recover sufficiently to combat infection.

There is still a difference of opinion as to whether or not the ureter should be removed at the time of nephrectomy. For ourselves we discontinued doing it some time ago for the reasons that (1) its excision adds materially to the severity of the operation and (2) we are not convinced that the removal of the ureter helps to relieve the symptoms as long as a tuberculous lesion remains in the bladder for if the ureter is extensively involved the bladder also is affected.

In the combined statistics of Drs Bunts Crile and Lower the mortality rate for nephrectomy in cases of renal tuberculosis is 2.3 per cent, while a recent series by one of us (W E L) comprising over 100 consecutive nephrectomies for various lesions shows an immediate mortality rate of less than 1 per cent. The remote mortality in the majority of cases has been due to tuberculous lesions in other parts of the body such as tuberculous peritonitis general miliary tuberculosis and pulmonary tuberculosis.

3 *The persistence of symptoms* We regret to say that too large a percentage of our cases still have persisting vesical symptoms, frequent urination being reported most commonly. For the relief of this condition nearly everything has been tried but as a rule with little or no success it should be noted however that in many of our patients the bladder had become so extensively involved and its capacity so reduced that immediate relief could not be expected. In the majority of our cases the irritation was relieved although in many cases some frequency of urination persisted. To this however the patient had become so accustomed that it no longer annoyed him greatly.

The necessity of prescribing a proper régime is too frequently overlooked. Many of these patients return to the environment in which they lived during the early development of the disease—too often an environment which affords no opportunity for a hygienic régime by which the patient's powers of resistance may be increased. These patients must be properly advised and placed where they may have the full benefit of those factors which aid in the arrest of the tuberculous process—fresh air, good food, and congenial surroundings.

As has been noted by Cabot and Crabtree very early cases with small multiple foci in the kidney often do not recover as promptly or completely as those cases in which there is a larger localized abscess because in the latter the tissues have developed a certain immunity. This fact, however is not an argument for deferring operation, for there is always the danger that other organs may become involved by the extension of the dis-

ease and thus far medical treatment has shown no cure for tuberculosis of any portion of the urinary tract. Prolonged treatment of these patients for other conditions is still too prevalent. A majority of the cases of tuberculosis of the kidney which are referred to the surgeon have been given an incorrect diagnosis and have been treated for non-existent lesions such as an encroachment of the uterus on the bladder if the patient be a woman or a specific infection, if the patient be a man. It is the duty of the urologist to educate the general profession so that they may recognize early the presence of tuberculosis of the urinary tract, and may differentiate the symptoms caused by this condition from those caused by other lesions.

#### STATISTICS

This paper is based on a study of the end results of nephrectomies performed by Drs Bunts Crile and Lower the series including 87 consecutive nephrectomies for tuberculosis of the kidney. Operations performed within the last year are not included since the end results cannot be determined.

*Immediate mortality* Among these cases there were two deaths within four weeks after the operations and before the patients left the hospital. The cause of the immediate mortality in the first case was probably shock the patient being in a very precarious condition before operation and the removal of the kidney difficult. This was one of our earlier cases and the operation was performed without the preliminary preparation now employed. The second patient lived three weeks after operation autopsy revealing the fact that the remaining kidney was decidedly tuberculous.

*Later mortality* Of the cases showing a later mortality two died of general tuberculous peritonitis four of pulmonary tuberculosis while the cause of death in the remaining four is not known. The longest interval between operation and death was seven years this patient dying of pulmonary tuberculosis at the age of 37.

*Persistence of the symptoms* Forty five replies were received to letters sent on January 1, 1916 in which complete data on the

present condition of the patients were requested. These reports were compared with the case histories to determine the relation of the persistent symptoms to those present before operation.

a. *Painful and frequent urination* In 48 per cent of the cases with painful and frequent urination before operation some bladder symptoms persisted abnormally frequent urination being the most common. The history of each of these cases showed that bladder trouble had extended over a long period prior to operation. Of the 9 per cent who reported no definite improvement in the bladder symptoms, each one had pronounced bladder involvement at the time of operation. Twenty per cent reported that they were in perfect health and all the rest that they were greatly improved. One man who had been operated upon eight years before reported himself as entirely cured although his history showed that for three years previous to operation he had complained of frequent urination a symptom which persisted for ten months after the nephrectomy.

b. *Pain in back and side* Pain in the back of a colicky nature was reported by 12 patients while 25 reported pain of varying degrees in the back, side or hip.

In those cases in which there were no demonstrable bladder symptoms at the time of consultation a definite history of bladder trouble at some previous time was always obtained. The chief complaint in these cases was either dull or sharp pain in the back. In these cases the X-ray was a valuable diagnostic aid while operation revealed an old caseous kidney which had resulted from either partial or complete autonephrectomy. Each of these patients made a complete recovery from his operation and was able to return to his old environment and to carry on his work as before. One case of this type was operated upon six years previous to this report and had made a complete recovery. All were entirely relieved of their former symptoms.

c. *Renal hæmaturia* Of the entire series 44 had hæmaturia, this being the only symptom in two cases in one of which the bleeding

was painless. Where the hæmorrhage was from the kidney it subsided after operation.

d. *Pus in urine* The majority of the cases, in which before operation pus was present in the urine in connection with bladder lesions reported that this symptom still persisted.

e. *Duration of symptoms* In our series, the shortest duration of symptoms before operation was three weeks, the longest, 19 years. Patients usually wait from eight months to three years after the appearance of the first symptoms before seeking surgical relief. We had six cases in which the symptoms had persisted more than four years five being women and one a man a physician. The prolonged period in the women was due in each instance to the fact that one or more of the genital organs, usually the uterus was considered the cause of the trouble. In the case in which the symptoms had persisted for only three weeks, the relief was almost immediate, and the patient rapidly gained in weight. This man had remained in good health to the time of the report, a period of two years. In another case a well nourished, robust looking man had complained for six weeks of sharp stabbing pains in the left abdomen associated with slight burning on urination, the first intimation of any pathological condition being the large amount of albumin present in the urine when he was examined for life insurance. Nephrectomy of a tuberculous kidney brought him immediate relief.

After operation the duration of symptoms referable to the bladder is quite variable three cases being recorded in which relief was immediate and three in which the symptoms disappeared within two months. Most cases in which the symptoms have persisted for more than a year before operation do not experience much improvement during the first year after operation. Of those of our cases whose symptoms had persisted to the time of their report only five considered themselves unimproved.

f. *Sex* The cases in this series included 46 women and 41 men.

g. *Age* The average age of our patients was 33 the oldest patient operated upon was

63 years of age the youngest was 16 46 were in the third and fourth decades of life and but nine were over 50 Our study therefore tends to confirm the conclusions of others that renal tuberculosis most frequently occurs before middle life Contrary to the statistics of many urologists the reports of our older patients were not favorable in spite of the fact that in two of the cases calcareous deposits were found in the kidney removed

*h. Family history* Of our cases 18 reported the existence of tuberculosis in some member or members of their families 43 gave a negative report while no statement regarding this point is found in the remaining case histories

*i. Kidney involvement* As far as can be determined in only two of the operative cases in our series were both kidneys involved. We are inclined to believe however that involvement of the second kidney is present oftener than our operative records show for judging from autopsy records about two-thirds of all cases are bilateral

*j. Weight* There are no exact records of the amount of weight lost before operation Among our operative cases in the last five years however with the exception of two one weighting 270 and the other 190 pounds all lost weight before operation The two greatest postoperative gains in weight were 74 and 75 pounds. Only two of our cases did not gain at all while one reported that he was losing weight. The average gain for the 31 patients who reported regarding this point was 31 3 pounds

*k. Technique of operation* The early cases in our series were operated upon under ether but during the last five years nitrous oxide with local anesthesia has been used. The general operative technique has remained unchanged A long oblique incision is made to give free access to the kidney and if possible to allow its removal without rupture Very rarely is it found necessary to fracture a rib in order to reach the kidney The ureter is separated to a point as near the bladder as possible without making another incision and after being ligated with chromic catgut is

cauterized either with the actual cautery or with carbolic acid If the wound becomes contaminated with pus, or if there is much oozing drainage is instituted

The main consideration in the operation is to produce as little shock as possible Shock is minimized by having the patient in good condition before operation by losing the least possible amount of blood and by gentle manipulation Hemorrhage is checked almost entirely by means of a special pedicle clamp which grasps the entire pedicle and allows the stump to be ligated with a non slipping ligature Every effort is made to avoid trauma and manipulation in removing the kidney in order to impair as little as possible the resistance of the local tissues and to prevent contamination of the wound with pus. In the earlier cases the stump was ligated with a linen suture. This retarded the healing of the wound since a troublesome sinus always persisted until the ligature was removed In recent years this delay in healing has been eliminated by the use of chromic catgut.

Any type of incision and of operative procedure may be used provided the patient is in good condition before operation and provided that hemorrhage and trauma are eliminated as much as possible With the exception of the two cases already cited, each patient in our series made a good recovery as far as the nephrectomy is concerned The persisting bladder symptoms alone gave trouble since of course the operation of itself did not relieve the local lesion except by preventing further infection from the diseased kidney

*l. Wound healing and postoperative complications* In 17 cases no data in regard to wound healing were given three reports stated that the wound had not healed three had gained in weight and had had no trouble aside from the inconvenience of dressing the sinus The longest period of time reported as elapsing before the wound healed was four years the shortest eight days In 29 cases the healing was complete within a month in 21 within a year in 16 before two years had elapsed

Suppression of urine was not reported in



any case and but one case of postoperative hernia

Of our cases 81 per cent are classed as unimproved this number including those who have lost in weight, those whose general condition is below normal and those who still have troublesome bladder symptoms or active lesions in the urinary tract. The cured cases comprise 60 per cent of all and include those who have gained in weight, those whose bladder symptoms have ceased

or subsided and those who have been able to resume their work.

#### CONCLUSIONS

1 Renal tuberculosis generally implies infection not only of the kidney but of the ureter and bladder also

2 The length of time during which bladder symptoms persist *after* operation is directly proportionate to the duration of the same symptoms *before* operation

## LIGATURE OF THE INNOMINATE ARTERY FOR CURE OF SUBCLAVIAN ANEURISM

By PAUL F. MORT, M.D. CHICAGO

THE first recorded ligation of the innominate artery was performed by Valentine Wott in 1818 the patient dying of sepsis and secondary hemorrhage on the twenty sixth day. In spite of the frightful mortality the operation was repeatedly done as it offered the only chance for cure of a condition otherwise hopeless.

In 1905 Sheen reported a successful case and collected all the reports of successful and unsuccessful cases. He also collected reports of attempted ligations of the innominate artery. In 1914 Thompson reported a case operated upon by himself which ended fatally and brought the literature down to date. As this operation is only rarely performed the following case operated on by myself in 1911 seems of sufficient importance to be added to the series.

F. W. T. male, aged 35 first consulted me May 20 1911 giving the following history. For the past five or six years he has been suffering from intermittent, paroxysmal pain, beginning in the deltoid region of the right shoulder and radiating to the arm and forearm. During the last two or two and one-half years he has taken treatments for this trouble from an osteopath, consisting of massage more or less skillfully carried out. About six months ago when the pain was particularly intense he was given an unusually vigorous treatment by the osteopath. During the manipulation the patient

states, the operator's knuckles made severe pressure in the right supraclavicular region, causing such pain that he cried out and protested against the treatment. Nothing unusual was noted at the time but next morning a pulsating swelling about as large as a pigeon's egg showed in the right supraclavicular fossa. This swelling gradually increased in size up to the time he came under my notice, the pain in the meantime increasing *pari passu*.

*Present history.* No sickness of any importance. No venereal history. Patient says before the pain began in the right arm he had for many years been employed as shipping clerk in a baking powder factory. In this capacity he daily handled many cases of goods that weighed about eighty pounds. These had to be piled on trucks and shelves and many of them lifted high above his head. Whether this muscular exertion acted as a causative factor I am unable to say.

Physical examination showed a fairly well nourished general condition. He had a somewhat anxious expression and the face showed evidence of physical suffering. The general examination was negative except that the radial pulse seemed rather harder than normal for a man of his years. In the right suprascapular fossa there was a swelling, fusiform in shape about as large as a hen's egg, which was limited internally by the outer margins of the scalene muscles. The overlying skin was unaltered and freely movable over the swelling. The tumor itself was soft and compressible. It pulsed synchronously with the cardiac systole, and on auscultation a loud systolic bruit was audible. The radial pulse was alike on the two sides, that on the right side not delayed.

*Diagnosis.* Aneurism of the third portion of the right subclavian artery. It was decided to ligate either the first part of the subclavian artery or the

innominate for the cure of the aneurism. The gradual but steady increase in size of the tumor as well as the suffering of the patient seemed to justify this radical measure.

On May 27 1911 the patient entered the Chicago Polyclinic Hospital. The next morning, after the usual preparation he was placed under general anesthesia with ether. An incision was made 13 centimeters long beginning 6 centimeters above the clavicle. After dividing the sternal and claviclar attachments of the sternomastoid muscle the inner third of the clavicle was resected subperiosteally and disarticulated from the manubrium. This procedure gave free access to the lower portion of the right common carotid which was followed down to the innominate. The right subclavian artery was traced outward to the inner border of the scaleni. The aneurism was then seen to involve the second part of the subclavian. In view of the fact that the arteries of the patient showed at least a moderate degree of sclerosis it did not seem desirable to place the ligature on the first part of the subclavian in close proximity to the aneurism. It was therefore decided that the ligation of the innominate was necessary. The vessel was isolated by blunt dissection and two heavy kangaroo tendon ligatures placed and tied. A third ligature was tied about the common carotid near its origin. Pulsation ceased at once in the aneurism and also in the right radial artery. Closure of the deep parts with catgut and the skin wound with silkworm-gut followed.

The patient was in good condition at the end of the operation which took an hour. The right arm was packed in absorbent cotton and placed in a slightly elevated position. There were no symptoms of cerebral disturbance. During the next few days there was considerable pain in the right arm, which necessitated a few hypodermics of morphine. The aneurism became hard and firm to the touch. At the end of two and one half weeks pulsation in the right radial was quite distinct, and at the expiration of three and one-half weeks pulsations began to reappear in the aneurism. The patient then left the hospital feeling well the neuralgic pain having almost entirely disappeared. The hand and arm remained somewhat atrophic and stiff for three months but persistent massage and passive motion eventually caused these to disappear entirely.

*Status presentis.* The patient now has occasional attacks of pain in the right arm which are some times precipitated by working. The aneurism measures 6 x 5 x 4 centimeters. The wall is firm and strong except on a small area about 2 centimeters in diameter. It has increased only slightly in size. The patient expresses himself as well satisfied with the result such as it is and persistently refuses a further operation for excision of the sac.

Up to the present time there are on record including the case here reported 53 ligations of the innominate artery of which 40 died and 13 recovered. Twenty-one were operated

upon in the pre antiseptic period (before 1871) with one recovery. The patient was operated on by A. W. Smythe of New Orleans in 1864 for a subclavian aneurism both the innominate and subclavian arteries being tied. In spite of secondary hemorrhage occurring on the fourteenth, thirty third and fifty first days the operation was followed by ultimate recovery. A ligation of the vertebral artery being found necessary on the fifty fourth day to control hemorrhage. The causes of death in the other cases are as follows: hemorrhage 13 sepsis 4 shock 2 and cause not mentioned in one.

Since 1871 32 cases have been operated upon with 12 recoveries, a mortality of about 62 per cent. The causes of death were as follows: sepsis and hemorrhage 9 hemorrhage 3 cerebral lesions anemia thrombosis 4 chronic nephritis 1 broncho-pneumonia, 1 cause not assigned 1 and shock 1.

*Effect of ligation on the aneurism.* Of the 13 cases that recovered 11 were operated on for aneurism. Of these 11 4 were cured permanently and in 7 the aneurism returned in one as early as the third day and one after ten years. Two of the cases that were cured had a ligation of the innominate and carotid and two a ligation of the innominate artery alone. Among the cases recurred, the innominate and carotid were ligated in two instances, the innominate carotid and vertebral in one, the innominate carotid and first portion of the subclavian in one and the innominate alone in three instances. The conclusion that must be drawn from these considerations is that the additional ligation of the carotid has little influence on the chances of a cure. To obtain this subsequent operations have been performed where ligation of the innominate carotid has proved inadequate. Sheen ligated the second portion of the subclavian artery to obtain a cure and Saigo twice made an excision of the aneurismal sac when ligation of the innominate proved ineffectual. To obtain a higher percentage of permanent recoveries without increasing the danger to the patient may not be possible. However it does seem that if the aneurism is sacular and not too large that Matas' method ought

If possible to be tried. If this method is not adaptable to the size or shape of the aneurism, excision of the sac might be attempted a treatment which proved successful in the two cases reported by Salgo. If neither of these two methods is possible a distal ligation of the axillary artery in addition to the proximal ligation of the innominate combined with the ligation of several or all of the branches of the subclavian might increase the chances of a permanent recovery.

As to the material to be used for the ligation it seems to me that there can be no question today. An absorbable pliable ligature of

generous size that will remain for three or four weeks or a little longer would seem to be ideal, and either kangaroo tendon or heavy chromicized catgut may be used. It might seem unnecessary at this period to draw attention to the necessity of strict asepsis in performing the operation. Still the occurrence of sepsis and secondary hemorrhage, after operation even since the beginning of the antiseptic period (cases of Gay<sup>1</sup> 1897 and Burns<sup>2</sup> 1908) serve as an excuse for emphasizing this self evident necessity.

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## EXPLORATORY LAPAROTOMY

ITS USE AND MISUSE

BY CHARLES H. PARKS, M.D., F.A.C.S., CAPT. U.S.A.

**E**XPLORATORY laparotomy is justifiable when used as a diagnostic recourse in connection with or following the use of all other available means to that end. Only after a complete and thorough examination utilizing all diagnostic aids may an exploratory incision be employed. By it is obtained the information which direct access to affected and correlating parts can give. Such a laparotomy obviously is a diagnostic measure but it should be the aim, as unquestionably it is the duty of the surgeon to limit the exploratory feature to the minimum. It then remains to determine further whether the condition found is operable or inoperable and if operable what surgery is warrantable. Without careful preliminary study of the case even the most experienced operator has no license to go in and find out, as so often is done following the mere application of hands to the abdomen and a glance at the chart. Such superficial work deserves more condemnation for the whole sale or the occasional cutter than does the shotgun cure all dose for the pill vendor.

It follows therefore that the misuse of an exploratory laparotomy is to open an abdomen

without previous complete examination. Too often it is the practice to make it a short-cut route because of its comparative simplicity and relative safety if it is granted that there is such a thing as a simple herniotomy or appendectomy.

On necessity using the knife without proper thought must plunge the wielder immediately into a period of uncertainty as to (1) what may be encountered (2) what to do with an unfamiliar difficulty (3) when to terminate an excursion into the unknown and (4) how to get back to land without losing either patient or prestige. The disastrous results of this uncertainty usually are not discovered until after the termination of the ordinary hospital convalescence.

In general modern asepsis has made exploratory laparotomy too easy and too safe. With even a limited surgical training the aseptic habit is quickly acquired making it possible for fools to rush in where angels fear to tread. Immediate danger to life is greatly lessened when the work is done in an up-to-date hospital, with the protection of the rubber gloves, sterile linen, instruments and sutures afforded. The knowledge and

training of an intelligent surgical nurse are provided an alert interne assists and a safe experienced anesthetist carries the patient through the danger of prolonged narcosis. The patient rarely has any conception of the thought care and experience involved in the routine technique which has been developed in that operating room and to which he owes his life. Naturally but incorrectly he credits this to the skill of his doctor. Therefore unfortunately modern asepsis has afforded an opportunity for a playground for ignorance, cupidity and deceit.

John B. Roberts (1) says: Reflection upon the causes of diagnostic error should lead to the value of encouraging a doubting mind and to a decided skepticism of the snap diagnosis. The gynecological bulletin board announces abdominal section or section. While formerly section meant autopsy it is now used I suspect to cover a reserved diagnosis. Sometimes it is the resort where doubt exists in the mind because of insufficient knowledge of the physiology and anatomy of the human organism and a careless application of the knowledge possessed.

The constant aim in medicine should be to lower the mortality rate. Internists and surgeons alike continually strive to clip off small fractions of their percentages of fatality. Death, or even the slightest degree of invalidism subsequent to operation seems more reprehensible than anything that happens to follow any other practice. Further surgical responsibility does not cease with the return of the patient to his room alive followed by a short convalescence devoid of pus. The symptoms must be cured or at least diminished.

Were it not for daily exhibitions of operations which resemble the results of railroad accidents a discussion of this question would be supererogation. It is a deplorable fact that in most hospitals it is not uncommon for a doctor to enter a case, prepare for the operation cut through the skin peck around on the peritoneum and then immediately beg the interne to tell him what to do next or in a panic request him to finish the job.

Incredible as it may seem utterly unfitted

and often with full knowledge of their unfitness many doctors will essay to operate and unfortunately will continue in the practice until the future develops some plan for their repression.

By way of illustration two incidents of recent occurrence are related.

First the case of a young woman aged twenty-four pregnant five months with a marked Graves disease the symptoms of which dated back several years. In the history is found a record of five different operations within the last two years. It will not be hard to guess that the first of these was an incision over McBurney's point to remove the appendix. The next was through the median line during which operation the surgeon claims to have removed the same appendix. Besides the appendix he also took with him one tube and one ovary. The next procedure was a dilatation of the cervix and the removal of some hemorrhoids. Then some more hemorrhoids were burned off and lastly the tonsils were Sluderized. This patient was in two different hospitals of some reputation.

During the course of these treatments the real condition, the hyperthyroidism never was discovered and the patient now has a suspicious spot in the right apex a heart poisoned almost to collapse eyes popping out of her head, tremor so great that she has difficulty in holding a glass of water and a uterus five months pregnant.

Second a woman of forty-five, with a biliary fistula of several years standing. The history shows two laparotomies and innumerable dressings including the use of probes and small curettes and the long-continued maintenance of a rubber drainage tube. In this case the diagnosis seems to have been made and confirmed as the doctor operated for gall-stones and removed two. He told the patient honestly that he felt another but was unable to get it out. He stitched the gall bladder to the skin and instructed the patient never to allow any more surgery as the procedure of closing the fistula probably would prove fatal. The resulting permanent drainage was so distressing that the patient again went to the operating-table, again came out alive, but was unable to obtain any information from the second operator regarding what had been done. Her fistula still persisted and more surgery was demanded. The fairly simple procedure of complete removal of the gall bladder with the stone in a pouch relieved the condition and cured the patient.

The first of these two cases shows operative work with no thought of preceding it with an intelligent diagnosis. In the second case a diagnosis had been made which the exploration of the abdomen proved. It shows more conspicuously however the unfairness to the

patient and to the good repute of surgery where one unable to cope with a not particularly difficult condition got beyond his depth.

Where in the category of a scientific calling should a man be placed who exhibits a handful of gall stones which he has just removed but who has sent the patient away with one undiscovered in an accessible part of the biliary tract and a gall bladder carefully stitched to the peritoneum or the skin? Or the so-called surgeon who leaves an appendix which has eluded his most careful search along the white line even to the turn of the splenic flexure. Where does the surgeon belong whose entire bag of tricks consists of an ability to remove a normal appendix, resect or remove one or both ovaries one or both tubes and perhaps drain a gall-bladder? He can have no conception of respect for the vitality of tissue especially the peritoneum no thought of the effect of resulting adhesions and no regard for the organic functions necessary to the future usefulness of his patient. Unfortunately his name is Legion.

Going a step further another group of operators thoroughly investigate and diagnose an abdominal case. Not infrequently before opening the abdomen, they decide upon the operative procedure to be undertaken. Therefore it happens that in their hands a gastro-enterostomy will be performed as the result of a fixed plan before operation without an examination of the stomach itself after opening the abdomen. A thorough examination of the stomach might show it to be normal and lead to further investigation of the abdominal contents with the location of the pathology in the gall bladder or perhaps the appendix, much to the benefit of the patient.

H. A. Black (2) in discussing a paper by F. Gregory Connell on Pseudo Appendicitis thinks that in chronic gastric disorders there probably is greater confusion than in any other condition within the abdomen as applied to chronic appendicitis. In these cases the roentgen ray, the test meal or even hemorrhage from the stomach, does not and should not convict that organ of ulcer. The absence of pain and tenderness does not absolve the appendix from possible guilt. Of course

these cases usually can be demonstrated by operation, but it is much more pleasant to be confirmed rather than confounded by our operative findings.

In abstract from an article by D. B. Pfeiffer (3) on factors influencing the present mortality of peritonitis is interesting. He concludes from the compiled statistics of the results of various preliminary treatments in cases of appendicitis complicated by local and diffuse peritonitis that, even before undertaking to operate intelligent care as dictated by experience is necessary. He protests against the stereotyped methods of treatment of abdominal pain and colics.

The great pitfall for the practitioner lies first in the fact that many abdominal pains are not due to surgical conditions and second in the difficulty of differentiating surgical disorders from the non-surgical in their earlier stages. Until a few years ago the purge was thought to be a very good introduction for the treatment of any disorder abdominal or otherwise. When the practitioner learns to treat all cases of abdominal pain with masterly inactivity during the period of indeterminate diagnosis when he does nothing that runs counter to the principles of treatment set forth, then the subsequent morbidity if not mortality from the acute abdomen will approach the vanishing point.

Again quoting Roberts (4) Potential dangers should not always lead us to take operative risks. Sometimes the anesthetic is more dangerous than the operation. A sharp knife is more dangerous in the hands of a clever cutter than a doubting mind in the skull of a thoughtful surgeon who believes that all problems cannot be solved by a keeo edge alone. Surgery must be regarded as a science a part of all science and not a mere scholastic act. If those who pose as surgical specialists wish to rank with the wise men of the earth. I freely admit my dubious mental attitude to dogmatists in surgery science and religion. The Creator seemed wiser than authors of the latest fads in operative technique. The human animal needs tonsils appendix mammary glands ovaries uterus and even the colon.

There is another phase of the question worthy of mention, namely the rush of an able man with too much business. The following cases have come to my attention recently

A patient with an indigestion went to one of the surgical mills and was placed in a ward for diagnosis. He was receiving the attention of the roentgenologist when on the morning of the third or fourth day the operating force took him to the operating room, where he was put to sleep and his gall bladder removed. In a short time it was found that it was a gall bladder near by that needed the ectomy. Later after proper careful scientific investigation an internist diagnosed the case as one of appendicitis. The appendix was removed followed by relief of the indigestion.

Two similar instances occurred elsewhere. A man in a ward being treated for typhoid and about convalescent was taken to the operating room, much against his protest anesthetized and his appendix removed. Fortunately he recovered. The appendix scheduled for operation was in the next bed.

A patient was being prepared for laparotomy and was partially anesthetized when apparently the thought occurred to the surgeon that he had better determine which side the hernia was on. The interne when questioned, did not know nor did the unwritten history sheet state. The patient was allowed to wake up and was asked what side the hernia was on. He was then re-anesthetized, and a brilliant herniotomy performed.

Allow me to relate one more incident illustrating a different variety of work. A referring man sent a patient to the hospital scheduled a laparotomy and called up the surgeon. The next morning the patient was anesthetized and prepared and when the surgeon walked into the operating room ready to begin he noticed a peculiar odor. Instead of proceeding with the laparotomy he made a vaginal examination and found an inoperable carcinoma. Inquiry proved that the operation had been advised from the symptom of abdominal pain alone and neither the referring man nor any of the hospital staff had made an examination.

Is it any wonder that we are in disgrace and that much of our business frequently comes to us only under protest, and because there is no other relief?

Far be it from me to attempt to put a finger upon the factor at fault. The responsibility is too widely distributed for that. My desire is to emphasize the well known fact that these evils exist. In some way somehow let us get together as honest thinking human beings and give to the patient the chance he deserves and our profession a chance to

get out of the mire. If it means a labor union let us follow the lead of our professional friends the school teachers. If it must be group medicine, as advocated by our friends in Boston let us endorse Cabot in his views and put our weight behind him.

It hardly seems possible that these extremes will solve the problem and no doubt we will continue to flounder continue to theorize — yes even agitate — to the time when we can get together for the benefit not only of our patients but also of ourselves. Confronted as we are with powerful insurance corporations beating down our fees labor unions demanding free state medical service for all whose incomes are one thousand dollars or under and our own constant efforts in preventive medicine and the elevation of license requirements for ourselves but not for osteopaths chiropractors and so forth the time has arrived for us to prove to the public, by giving them value received that we no longer will be their football.

To escape the toe of the boot of every amateur legislator and the shyster lawyer we must get back into a corresponding position in the mind of the public to that occupied by the general practitioner and household adviser of several decades ago. How can we expect to obtain — above all to deserve — the respect of the public if we cannot at least respect ourselves and each other? It is the disgrace of the commonly understood exploratory laparotomy and kindred procedures — surgical obstetrical venereal laryngological etc. — which often prompts the layman and frequently the doctor to think of medicine as a fake thus encouraging the Christian Scientist and his kind.

In conclusion I will submit that.

- 1 Exploratory laparotomy has a more limited place than usually accorded it and that place is as a scientific diagnostic procedure only to be undertaken when other diagnostic aids have proved inadequate.

- 2 Following its diagnostic employment it should be taken advantage of to determine the possibilities of operative treatment.

- 3 In acute conditions it should be preceded more often by careful treatment as well as diagnosis.

4 It should not be undertaken unless the operator has the qualifications, resulting from preliminary training and experience to carry out to a successful termination, expeditiously and safely any maneuver of operative technique demanded by any abdominal conditions whatsoever

5 Before operating the surgeon should have a keen sense of respect for tissue, appreciation of the value of organs to the human economy accompanied by a reverence for delicate manipulation and horror of tissue mauling

6 The careful planning of an operation before making the incision is wise. However it should not be so fixed as to be inflexible should direct examination demand a change

7 In surgery the only place for haste is in the technique developed by experience governed by the fact that the shorter the period of the anesthetic and manipulation the less the shock. Haste and its accompanying carelessness due to an ambition for

a time record or to a rush of business are inexcusable.

8 Operation following a hasty diagnosis on the part of the surgeon himself is deplorable. Operation without personal examination, on the diagnosis of a referring man seems incredible but it is practiced nevertheless.

9 The future should hold some intelligent, honest, comprehensive reform for the elevation of the ethics of surgery. The law of the survival of the fittest will not solve the problem. Organizations among surgeons themselves can be only a beginning. Legislation never has abolished evil in society and politics and cannot do so in medicine. Reform is needed and it must come, as do all lasting useful reforms by spontaneous realization on our part of the harm done us by unintelligent and dishonest practice

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## CONGENITAL ABSENCE OF THE UTERUS AND VAGINA

### WITH REPORT OF SIX CASES

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**C**ONGENITAL absence of the uterus is a sufficiently rare anomaly to justify this report of six additional cases. Four of these have occurred in the gynecological department of the Johns Hopkins Hospital in the quarter century of its history while the other two have recently come under my observation in private practice. According to Burrage (1) the first instance of this condition was described in 1572 by Realdus Columbus. Since that time several hundred cases have been reported in the literature. Most of the reports unfortunately are very brief and usually in complete sometimes leaving doubt as to the correctness of the diagnosis.

#### ETIOLOGY

When one considers the embryology of the generative tract in women it is easy enough to explain the mechanism so to speak of practically any of the numerous anomalies which may occur in this part of the body. The underlying cause for these malformations, like that of malformations and monstrosities in general is of course still unknown. It should be remembered that from an embryological point of view the female generative tract consists of three segments. The lowest of these comprising the vulva and the lowermost portion of the vagina, is developed largely from the external epiblast of the body (the genital tubercle, genital fold and genital

furrow) The middle segment embracing the uterus tubes and vagina, is formed by the fusion of the muellerian ducts while the uppermost segment i.e. the essential organ of sex the ovary is formed from the so-called genital ridge on the mesial surface of the wolffian body (Mall and Keibel) Absence of the uterus is clearly due to a failure of development of that portion of the muellerian ducts whose fusion normally forms the uterus

In the great majority of cases the defect involves also the lower portion of the muellerian ducts so that absence of the vagina is usually associated with absence of the uterus Abnormalities in the development of the lower embryonic segment are responsible for the anomalies of the external genitalia which are found in various forms of pseudohermaphroditism True hermaphroditism on the other hand involves the uppermost segment, presupposing an anomaly in the development of the essential sex glands i.e. the ovary or testis With the latter two groups of maldevelopment however we are not directly concerned in this paper

*Influence of heredity* While there is no reason in the great majority of reported cases of absence of the uterus to assign any important rôle to hereditary influence, there are nevertheless a certain number of instances in which this factor appears to have been to say the least, not negligible For example Boston (2) reports a rather remarkable trio of cases occurring in three sisters Two were single being aged 22 and 27 respectively The third was a widow of 33 In all three the vagina was present but the uterus was absent The same author mentions two other cases occurring in two married women who were cousins Phillips (3) records two cases in two sisters both of them married while Squarey (4) speaks of the cases of three sisters who had never menstruated Nelson (5) finally reported three cases of absence of the uterus occurring in three of a family of 5 sisters

#### PATHOLOGY

*Menstrual molimina* A review of the reported cases of absence of the uterus impresses one with the frequency with which in the absence of menstruation these patients com-

plain of definite molimina In 4 of my 6 cases there was a definite history of regularly recurring monthly attacks corresponding to the periods of normal menstruation The symptoms complained of by the patients were pain or heaviness in the lower abdomen back ache and usually more or less headache This has been the common observation in most of the other recorded cases To me the occurrence of definite menstrual molimina in these cases of complete absence of the uterus is a matter of considerable interest It is I believe the common impression that the subjective local symptoms of menstruation are due to the pelvic congestion associated with the process It would therefore seem that even when the uterus is absent a periodic pelvic hyperemia still occurs the only difference from the normal being that there is no menstrual overflow by way of the endometrium It seems obvious therefore that the ovaries when present in these cases, as they almost always are functionate quite normally ovulation proceeding with regular rhythm with the formation of the corpora lutea which are responsible for the menstrual phenomenon (6) It would be interesting to have the opportunity for careful histologic study of ovaries removed from such cases

*Vicarious menstruation* Although no mention is made of vicarious menstruation in the majority of case reports of this anomaly nevertheless the number in which it has been noted is sufficiently great to justify the statement that this phenomenon is certainly more frequent when the uterus is absent than when it, and the vagina are present As a rule it takes the form of nosebleed as in the well marked case reported by Gillmore (7) Occasionally a bloody discharge from the bowel has been noted as occurring each month as in the cases of Hedley (8) and Harlan (9) In the latter's patient each menstrual mola was followed by a bloody flux lasting several days The occasional occurrence of one form or another of hemorrhage it need scarcely be said does not constitute vicarious menstruation The term should be confined only to extragenital hemorrhage which regularly accompanies or supplants the normal menstrual discharge



*General development* As far as the general characteristics of the individual are concerned cases of absence of the uterus are of two general types. In the larger group illustrated by the first five of my cases the genital defect is the only abnormality exhibited by the individual. In every other way the development and characteristics are typically feminine. In a smaller group of cases, however there is a more or less pronounced admixture of the masculine element, the extreme form being found in instances of true hermaphroditism. In cases of this kind there is usually associated some form of ambiguous malformation of the external genitals, and not infrequently a single or double hernia of the genital gland—the ovary or testis as the case may be. A large number of cases of this type have been collected by Mary Putnam Jacobs (10) Swasey (11) and others.

*Sexual function* In the great majority of reported cases in which any mention is made of the sexual function, sexual feeling is described as being normal. Not infrequently the urethra is found enormously dilated indicating its utilization for purposes of coitus. Jacobi, however is inclined to believe that the apparently large urethral canal in many cases really represents a persistent urogenital sinus. Hedley (8) points out that the dilatation of the urethra by attempts at coitus is initiated by a drawing downward of its orifice into the pit of the rudimentary vagina, bringing it directly into the line of pressure.

*Associated anomalies* In not a few cases, as has already been stated absence of the uterus is associated with hernia of one or both ovaries. Another anomaly which should be borne in mind when absence of the uterus is discovered, is misplacement of the kidney. An interesting case of pelvic kidney in association with absent uterus has been reported by Cullen (2) and a somewhat similar instance is recorded by Brettauer (13). In both of these cases the renal anomaly though unsuspected beforehand was fortunately recognized at operation and thus removal of the kidney averted. The importance of this lies in the fact that in both these cases the displaced kidney was the only one possessed

by the patient. A similar anomaly in a case reported by Polk (14) was not recognized until after removal of the single kidney with of course a fatal termination. In at least one case described in the literature that reported by Bullard (15) absence of the uterus was associated with what seems to have been a persistent cloaca. The vulva and the vaginal orifice were normal. When the finger was passed into the canal for 2.5 or 3 centimeters, it came to an annular constriction evidently the internal sphincter of the rectum. When the patient was told to contract the sphincter the grasp on the finger was quite perceptible, though not as strong as that of the normal sphincter. Just beyond the constriction were moulded feces and a roomy rectum.

#### DIAGNOSIS

While in a certain number of cases the diagnosis of absence of the uterus can be made without anesthesia, it is questionable whether the latter should ever be omitted in order to establish definitely the existence of the anomaly. Aside from sparing the sensibilities of the patient the anesthetic affords an opportunity of making a far more thorough and satisfying examination than can possibly be made without it. There are some who would claim that in practically all these cases the uterus is really present but is exceedingly rudimentary. The findings in Case 3 of my series which came to laparotomy would seem to disprove this. At best the contention is largely an academic one, for certainly a uterus which cannot be palpated or perhaps even seen which lacks function and which is associated with absence of the vagina, may be looked upon, from the patient's point of view as absent. The confirmatory value of laparotomy in the diagnosis of such cases, provided some definite indication exists, is obvious.

#### INDICATIONS FOR TREATMENT

I shall not discuss at any length the treatment of this condition, except to summarize my own convictions. The circumstances of the individual case must, after all be the principal governing factor in its management. In the case of the single girl in whom absence of the uterus and vagina is diagnosed

it is the duty of the physician to explain the condition fully to the patient or to her parents, so that an intelligent decision may be made as to the course to be pursued. The willingness or unwillingness of the patient to sacrifice the possibility of marriage is as a rule the factor which leads her to decide as to whether or not an operation is to be attempted for the making of an artificial vagina. When the relative risk and the uncertainties of complete success are impartially presented I believe that in the majority of cases as in the one recently observed by me (Case 1) the patient will decide against operation especially in view of the impossibility of her ever bearing children.

If however the desire to be able to assume the marital relation leads a patient to decide upon operation, there would seem to be no question as to the justification of the surgeon in performing it. These remarks I need scarcely say apply only to the cases in which both uterus and vagina are absent. The presence of the vagina although the uterus is absent, makes the problem an entirely different one.

In the less frequent cases in which absence of the uterus and vagina is found in women who are married both husband and wife will usually consent to the performance of an operation which can scarcely fail, if properly performed to remove more or less completely the bar to coitus. If there is sufficient vaginal canal to allow of satisfactory coitus as in my Case 2 there is no need for surgical interference.

*Operative treatment.* When it has been decided to resort to the making of an artificial vagina several methods present themselves for consideration. The old method of dissecting the perineal body between the bladder and the rectum and inserting a plug to keep open the canal thus made has very properly been discarded inasmuch as cicatricial contraction of the newly made vagina is the invariable result. The method which has been employed in perhaps the majority of cases has been to utilize the pudendal tissues and perhaps even the skin of the thigh to line more or less completely the canal made by separating the bladder from the rectum.

Various modifications of this general method have been described by Burrage Ferguson Carson and others. Aside from their uncertainty all these methods possess the disadvantage that a canal lined with dry skin can never be considered an altogether satisfactory functional substitute for the normal vagina with its moist lining of mucous membrane. While mucous membrane may in time through the process of hornification assume the characteristics of skin the reverse is not true.

For this reason as well as for other advantages which it possesses the operation described by Baldwin (16) in 1904, and again in 1910 would seem to commend itself. In this operation a loop of small intestine the ileum is utilized for the making of the new vagina.

A transverse perineal incision is made at the site of the vaginal outlet. The perineal tissues are dissected between the bladder and rectum until the peritoneum is reached. The abdomen is then opened and a loop of ileum about 12 inches long is carried down with its mesentery into the cleft made from below the peritoneum having of course been opened. The ends of the loop are severed from the ileum above the two cut ends of the latter being anastomosed with a Murphy button. The loop of bowel which is to form the vagina is closed off above the peritoneum being sutured above the cut ends. The lower end of the loop is opened the bowel wall being sutured to the skin edges. After a number of weeks the septum between the two segments of the loop is removed. Baldwin reports that in the six cases in which this place of operation had been tried up to 1910—four of his own one reported by Mon and one by Mueller—the functional result had been excellent. There had been no mortality although the operation is obviously one of some magnitude.

CASE 1 L. S. a white girl of 20 angle was referred to me by Dr B. S. Hanna May 29 because she had never menstruated. She had always been somewhat frail but had never suffered from any severe illness. The family history was of no special significance except that her mother had not commenced to menstruate until the age of 17 and one aunt not until the age of 20. The patient herself

had always enjoyed comparatively good health, her only complaint being of nervousness." Once every 4 weeks for a period of from 4 to 7 days she suffered with pain and heaviness in the lower abdomen and back, together with a pronounced exaggeration of her nervousness. There had never been any periodic nosebleed or other form of vicious menstruation.

The patient was a girl of slender build, 5 feet and 5 inches tall, and weighed 90 pounds. The mucous membranes were of good color. The breasts were fairly well developed and the axillary hair normal in amount. The heart, lungs and thyroid gland were all normal, the pulse usually ranging from about 80 to 90. It was thought that the non-appearance of the menses might be due to an imperforate hymen, and pelvic examination was therefore advised.

The hymen was found to be intact but not imperforate, there being a tiny orifice about 5 millimeters in diameter leading into a blind pouch about 1 centimeter deep. Bimanual examination, with one finger in the rectum, showed an entire absence of the uterus, although both ovaries were palpable. In order to study the condition more thoroughly the patient was admitted to Mercy Hospital, where an examination under ether was made on June 9.

The above findings were confirmed. In order to establish definitely the absence of a vaginal canal, an incision was made through the hymen extending downward from the rudimentary pit above described. This was deepened so as to open the perineal body but no vaginal canal was found. Clippings from the tissue lining the cleft showed no trace of epithelium.

Bimanual examination again indicated the entire absence of the uterus. Nothing was to be felt in the normal position of the latter except a delicate transverse band like structure as if there were a fusion of the round ligaments of the two sides. Both ovaries were easily palpable, being of average size and freely movable.

**CASE 2.** Mrs. W. P., age 32, married, was referred to me on October 28, 1916 by Dr. B. V. Kelly, her complaint being of sterility and of non-appearance of the menstrual flow. Her family history was negative. For several years the patient had suffered with petit mal, being taken several times each day with spells during which her mind became a complete blank for a period of several months. Otherwise her previous health had always been good. She had been married 4 years, and, according to her statement, had been able to fulfill her marital duties sexual feeling being moderately well developed. Menstrual menses had not been noted. The patient was of slight build, 5 feet 4 inches tall, weighing 110 pounds. Breasts and thyroid were normal and the pulse was 90 at the time she was seen.

On examination, the vulva was found to be perfectly normal. The hymen was absent, and the vaginal orifice seemed to be of normal caliber. On introducing the finger into the canal, however

it was found to end blindly at a depth of 3.5 centimeters, the upper two thirds of the vagina being absent. The vaginal mucosa was normal in appearance, the characteristic transverse corrugations being well marked. Toward the upper end of the vaginal pouch there was some narrowing of the canal the blind end being quite smooth, with no trace of a cervix. By bimanual examination a tiny nodular thickening could be palpated at the usual site of the uterus, the ovaries also being palpable. There was no apparent connection between the rudimentary vagina and the tiny nodule just mentioned. Inasmuch as the patient was very tractable and the abdominal walls soft and thin, it was not considered necessary to subject her to examination under an anesthetic. Coitus having been carried on with satisfaction to both husband and wife no treatment seemed to be indicated.

**CASE 3.** G. D., (Gyn. No. 19543) a white girl of 18, single, was admitted to the gynecological clinic of the Johns Hopkins Hospital on July 31, 1913. Her complaint was that there had been no appearance of the menstrual flow. There was nothing of significance in her family history or in her own previous history. For one year the patient had suffered with attacks of pain in the lower abdomen and occipital headaches, these symptoms appearing regularly, once a month and lasting several days. She had been examined by a physician and told that the hymen was imperforate.

The patient was well nourished, and of normal build. The lips and mucous membranes were of fairly good color. The abdomen was of normal outline, the breasts well developed, and the axillary and pubic hair normal in amount and distribution. The thyroid was easily palpable but there was no tachycardia or other indication of hyperthyroidism. There was considerable tenderness in the right iliac fossa.

On August 4, 1913, a thorough examination was made under anesthesia. The clitoris, the labia majora and minora, and the urethra were all quite normal. The hymen was apparently completely closed though there was no bulging. The vagina was almost completely absent, being represented by a small tract 3 centimeters in length and with the diameter of a uterine sound. By bimanual examination with one finger in the rectum, the adnexa were felt but no uterus could be made out.

In view of the pain and tenderness over the right iliac fossa, it was thought wise to open the abdomen. The uterus was completely absent. Both tubes and ovaries were present and quite normal, the tubes being slightly larger and their walls somewhat thicker than the average. Medially they tapered to a mere cord, running forward and bleeding with the round ligaments which formed a band across the pelvis just beneath the base of the bladder. The appendix was moderately distended, and was removed.

**CASE 4.** A. M., (Gyn. No. 11076) colored, age 17, was admitted to the gynecological clinic of the

Johns Hopkins Hospital on February 23 1904. She had never menstruated. Every month for 3 or 4 days she suffered with pains in both ovarian regions backache and headache. There is some pain in the intervals, also especially on walking and bending. There has never been any nosebleed.

The patient is a healthy looking negress. The gums and mucous membranes are of good color the breasts well developed and firm.

Under ether an examination was made the day after her admission. The pubic and axillary hair was moderately well developed. The labia majora and minora and clitoris were normal. The nrethral orifice was enlarged and reddened, the opening of Skene's ducts being somewhat enlarged and giving off a small amount of purulent discharge on squeezing. The hymen was apparently imperforate. Bimanual examination, with a finger in the rectum, showed complete absence of the uterus and vagina. A transverse band could be felt behind the bladder, giving an impression as of a fusion of the broad ligaments in the absence of the uterus. The tubes were not palpable but a normal-sized and fully movable ovary could be felt on either side. No operation was done.

CASE 5 M C (Gyn. No 10138) white age 16 was admitted to the Johns Hopkins Hospital on December 13 1902. She had been in bad general health for 3 years and to this was attributed the non appearance of the menses. Every month, for these 3 years she had complained of severe aching in the back and lower abdomen, together with headache. This discomfort lasted 2 or 3 days. The last such attack had occurred 2 weeks previously.

The patient was a fairly well nourished girl, the face being rather pale, but the mucous membranes being of a fairly good color. Hemoglobin 75 per cent. Heart and lungs were normal. There was some tenderness in both iliac fossae especially the left. On this side, just above the upper half of Poupart's ligament was an indistinct roundish mass.

The external genitalia were normal. There was no vagina, its site being marked by a little pocket, one-half inch deep and scarcely wide enough to admit the little finger just below and a little to the right of the urethral vestibule. By rectal examination no uterus could be found. Both ovaries were palpable, and were of normal size.

CASE 6 L P (Gyn. No 5016) white single, age 20 admitted to the Johns Hopkins Hospital on March 6 1898. Family history was negative, except that menstruation had appeared rather late in the case of her 3 sisters, at the ages of 15 16 and 17 years respectively. A great aunt had not menstruated until after the age of 19. The patient had long been subject to headaches but there was no regular periodicity in their recurrence. With the exception of a slight blood tinging in August of 1897 there had never been any vaginal bleeding. This

tinging followed marked fatigue and was not looked upon as a menstrual discharge. In April 1897 there was frequent nosebleed but none since. Frequent attacks of nervousness and depression were complained of.

The patient was rather tall, of slender build, with very little subcutaneous fat. There was an absolute lack of the characteristically feminine roundness of the figure, which was in a general way cylindrical in shape. This was indicated by the fact that the bust measured 71.5 centimeters the hips between the crests of the ilia 73 centimeters and the thighs between the trochanters 86 centimeters. There was apparently an entire absence of gland tissue in the breasts, the areolae lying flat on the muscle. The nipples were only 5 millimeters in diameter and were elevated only about 1 millimeter above the surface.

Examination under ether was made on March 7, 1898. The mons veneris was small and contained little fat. Only a few scattered hairs, 3 to 4 centimeters long marked the skin of the mons. The labia majora were of the type of a girl of 13 or 14 before puberty. Like the mons they were covered with a light capillary growth. The clitoris was normal. The labia minora were infantile measuring 2 centimeters in length and 3 millimeters in width. The urethral orifice was found at the apex of a little pit. The vagina was represented by a depression 2 centimeters deep. Bimanually with one finger in the rectum there was no trace of vagina, uterus or ovaries. There was, however, at about the middle of the pelvis, a sharp border running across from side to side. In the right inguinal region there was an ovoid body about 3 x 1.5 centimeters in the position of the external ring. It could be displaced downward into the right labium but could not be put back into the abdominal cavity. This body was obviously one of the sexual glands although its exact nature, whether ovary or testis, could not be determined.

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# PRINCIPLES GOVERNING THE SPONTANEOUS REPAIR AND OPERATIVE CLOSURE OF VESICOVAGINAL FISTULÆ

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## I. INTRODUCTION

TO master the technique of vesicovaginal fistula operations requires a longer apprenticeship than any other individual operation practiced in gynecological surgery. Complicated cases, even in experienced hands may require repeated operation. If the bladder sphincter has been totally destroyed, it may prove impossible to restore continence. The current explanation offered for the difficulty encountered in the cure of vesical fistulæ is that inaccessibility of position, the abundance of scar tissue for maturation, the constant wetting by infected urine, etc., hinder union. Nevertheless as is well known, many even large fistulæ resulting from childbirth and occurring in the infected birth canal amid bruised and sloughy tissues heal spontaneously, while others often much smaller in size prove refractory to repeated operations. The same lack of uniformity in behavior applies to fistulæ resulting from operative interventions, such as those following vaginal or abdominal hysterectomy.

The cause of this difference in the behavior of vesical fistulæ has become clearer to the writer during the course of the last few years since he has studied the nature of the injuries in individual cases. Comparison of those cases which healed spontaneously with those which failed to close without operation, bears testimony to the fact that whenever the bladder was freed and mobilized (either spontaneously during the progress of labor or purposely during the course of operation) spontaneous healing occurred more frequently. Apparently the combination of two factors favors repair — mobilization allows the bladder to contract and thus to diminish the size of the opening and mobilization also favors the gliding and displacement of the tissue planes one upon another so that broad raw areas come into apposition. These two factors play a rôle far more important than the method of suture or the material used for

approximation. The writer is in fact, convinced that bladder defects with the exception of those at the neck will heal without suture if these two requisites are met.

This paper aims to show how these principles can be applied more largely to our operative technique so as to improve both the certainty of result and to standardize the operative procedures.

Since gynecological surgery has become more widespread and popularized, it is practiced not merely in large centers but also in the small towns and villages. Therefore individual operators can no longer expect to obtain the same wealth of clinical material, as the pioneers in the field of vesicovaginal surgery disposed of. Consequently it is even more important today that the occasional operator have at his disposal methods which require little or no special training. Sims (1), the father of the fistula operation in America, does not mention the number of cases he operated upon but Emmet (2) gives a casuistic of 128 cases and Gustav Simon at Rostock (3) during the course of a few years treated 40 cases.<sup>1</sup>

Although advances in obstetrics have greatly lessened the occurrence of vesicovaginal fistula due to childbirth the great increase in the number of pelvic operations has multiplied the incidence of postoperative fistulæ to a degree which even today makes this serious affliction not too uncommon.

The basic literature is contained in the works of Sims, Emmet and Simon just referred to. The later literature is readily accessible in works such as Veit's *Handbuch* (Stoekel 5) and Kelly's *Operative Gynecology* (6) while the more recent volume of

<sup>1</sup> A more recent large and interesting casuistic covering a period of years appearing from L. Joffe's clinic in Budapest (7) indicates that even during that period of which 3 were treated by operation, 5 per cent being cured. No real improvement in the treatment of complicated conditions can be noted if those patients operated upon in the earlier periods are compared with those delivered in more recent times. This record indicates that the improvement in the treatment of vesicovaginal fistula has not kept pace with the other advances in gynecological surgery.

Kelly and Burnham (7) gives a concise résumé of all of the standard methods of operating. Further and more detailed reference to the literature will, therefore, be dispensed with, as much of it is solely of casuistic interest.

## II CASUISTIC

The casuistic upon which this article is based comprises 22 cases including three fistulæ which healed spontaneously and three cases of incontinence due to injury of the sphincter vesicæ without communication with the vagina. Almost every conceivable form of fistula was encountered from small simple openings to complicated injuries which entailed loss of the entire neck of the bladder and urethra. One vesicocervicovaginal fistula and a fistula perforating a transverse vaginal septum are included in the series.

These cases were admitted to the First Gynecological Service of Mt. Sinai Hospital (attending gynecologist Dr J. Brettner) and were operated upon by Dr. Brettner, the late Dr. S. M. Bruckner, Dr. S. Geist, and the writer during the course of the last 12 years. Upon 19 patients 38 operations were performed. Of these patients 14 were discharged cured, one greatly improved, three improved, and one unimproved. *It should be emphasized that of the 5 patients not cured 4 had been previously operated upon from one to six times before admission to the hospital.* This fact is mentioned because it demonstrates the great responsibility assumed by an operator who undertakes the repair of fistulæ. An ill-planned or badly executed operation especially an operation which sacrifices normal tissues may convert a curable condition into an incurable affliction. Short extracts from the histories serve to illustrate the difficulties encountered and also furnish sufficient comment on the errors to be avoided and the principles this article aims to emphasize.

## III HISTORIES

**CASE 1.** T. W. age 35, suffered an infection after labor. Three months before admission, tracheorrhaphy had been done. Following this there were paravaginal exudates and abscesses which, at intervals required incision through the vagina perineum and above left Poupart's ligament. Necrosis of bladder followed after through-and-through drainage. The fistula was inaccessible.

After the suppuration had ceased complete supra pubic hysterectomy was done together with trans peritoneal suture of the bladder. Cured.

**CASE 2.** A. N. age 25 had had a complete hysterectomy for fibroids at the fifth month of pregnancy five months before admission. There was an opening in the fornix  $\frac{3}{4} \times \frac{1}{4}$  inch flap-splitting operation cured. Reopening of fistula during coitus. Repetition of operation, cured.

**CASE 3.** B. G. age 26. At age of 13 was operated upon for hæmatocolpos. One year previously had been operated on at the Mt. Sinai Hospital for *transverse vaginal septum* situated close to the cervix (crucial incision). Four months before present admission, labor had been induced for dead foetus. Since then there had been a leakage. The cervix was hidden by recontracted septum. In the anterior part of septum there were two small fistulæ which above the septum led into both bladder and cervix. The septum was split. Sims operation. Cured. (Figs. 1 and 2.)

**CASE 4.** A. S. age 35. A fistula developed after complete hysterectomy for fibroids with an opening 4 centimeters in diameter. *Flap splitting* cured. Later a vesical stone developed and repeatedly reformed. (For further history see paragraph dealing with Diverticula and Stone Formation.)

**CASE 5.** R. H. age 39. A fistula appeared after panhysterectomy for diseased adnexa due to necrosis of vault. Suprapubic transperitoneal liberation of the bladder revealed much exudate and a small fistula remained. On second admission a flap-splitting operation was done and the patient was cured. This patient developed a collar-hut-on-shaped stone. (For further history see Diverticula and Stone Formation.)

**CASE 6.** M. S. age 21. 6 weeks previously operated upon for cervical stenosis and hæmatometra, since which there has been leakage. In front and above the scarry cervix there is a slit like fistula  $\frac{1}{4}$  centimeter long. Bladder was mobilized by cutting through the cervical tissue and the defect was sutured. The anterior lip of the cervix was split and sutured thus transposing the external os into the neighborhood of the internal os. Cured. (Fig. 3.)

**CASE 7.** C. B. age 50 had had a panhysterectomy for persistent menorrhagia since which there has been leakage. Readmitted to hospital after 6 months at which time there were two small openings in opposite angles of the vaginal scar. The bladder was partly mobilized and the openings sutured. A small opening developed in the center of the scar. Sims operation was done minute leak. Cure by intravesicular cauterization (D. Arsonval current).

**CASE 8.** F. S. age 51. Leakage had been present since Wertheim operation for carcinoma of uterus. Five months later a small opening near



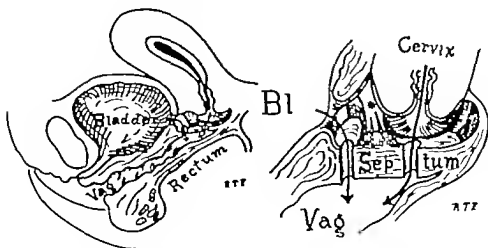


Fig. 1 Case 3. Fistula through transverse vaginal septum. Sagittal section showing vesicovaginal fistula and communications for urine and uterine discharge.

Fig. 2 Case 3. Same as Fig. 1 region of fistula and cervix drawn on larger scale. Asterisk on section of dense adhesions separating vesical and uterine openings.

the fornix was closed after full mobilization of bladder cured. No recurrence of carcinoma up to present (2½ years) (Figs. 4, 5 and 6)

CASE 9. G B age 25 4 children alive last difficult labor, 5 months previously stillbirth since which there has been leakage. Operation refused at two hospitals because of situation of fistula (?) declared incurable. Projecting red mass above and to right of cervix fixed to fornix and pelvic wall. Attempt to mobilize from below had to be abandoned because of uncontrollable hemorrhage. *Suprapubic transperitoneal laparotomy* complete hysterectomy and right scalpingophorectomy (for technique see inaccessible fistulae) freeing of bladder by sharp dissection from right pelvic wall after ligation of right uterine artery far laterally and freeing of ureter, suture of gauze into bleeding parametrial area, incomplete suture of bladder. Leakage. Permanent catheter for 28 days. Cure. (Fig. 7 8 and 9)

CASE 10. D S age 35 6 months before admission induced abortion (because of tuberculosis) a few weeks later ligation of tubes *per vaginam* since which there has been leakage. There was a very small opening one half inch above the cervix. Sims operation cured.

CASE 11. M B age 19 induced labor at eighth month because of eclampsia since then leakage. Urine dribbles from cervix through a small opening one half inch above external os. The bladder was fully mobilized and the opening and cervix sutured. Cured.

CASE 12. R. G. age 27 2 children alive last child stillbirth difficult labor since then leakage urethra torn. Behind the tear are two small vesicovaginal fistulae a plastic was performed on urethra and the fistula closed later three Gersuny operations were done (liberation and twisting of urethra on its longitudinal axis) Unimproved.

CASE 13. I. S., age 29 leakage followed laparotomy for adhesions one operation for fistula before admission at which opening was closed but incontinence continued. Three Gersuny operations, unsuccessful. Repeated bard paraffin injections some improvement. Exposure of bladder neck, evacuation paraffin pockets, sutures to narrow neck. The patient remained about the same continence imperfect.

CASE 14. L. M. age 27 Leakage had persisted since difficult labor 10 months before one operation had been done for fistula before admission. The cervix was buried in scar tissue and there was a defect of the lower half of the urethra and anterior bladder wall. (1) A vaginal flap plastic was done but did not heal. (2) Double Schuchard incisions were made, two fistulae were united and the hole closed, leaving a small opening at the neck. (Figs. 3 4 and 5) Reconstructive operations were done forming a new urethra because of necrosis we could not unite the canal with the bladder opening. The patient was content when lying down. Refused interposition.<sup>1</sup>

CASE 15. S S age 46, 8 children. Leakage had persisted after operation for cystocele. Six operations had been done previous to admission. (1) Several small fistulae were united by incision and sutured—flap splitting. (2) Construction of new urethra from vaginal flaps (Figs. 11 and 12) and suture to bladder. Repeated paraffin injections at bladder neck. (3) Closure of minute fistulae at junction of canal of bladder and reefing of new urethra. Some continence with pressure pessary (Figs. 9, 10 and 11)

CASE 16. See under V V F with destruction of sphincter Case 3

After having been lost sight of for 3½ years this patient has returned and desires further treatment. She is continent only when lying down.



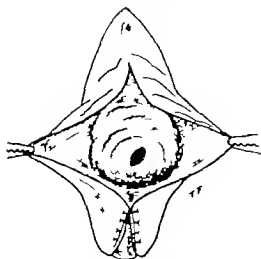


Fig. 3. Case 6. Vesicovaginal fistula, hematometra from cervical atresi. Compel to liberation of bladder, preceding repair of fistula. Incision of anterior lip of cerv. media line and plastic repair transperitoneal on upper rd.

Cases 7, 8 and 9. Although respectively due to childbirth trauma (falling on fence picket) and slow development of incontinence at menopause, these cases were all healed by free mobilization of the bladder. (1) Cases 7 and 8 first repair of fistula at vesical neck to size of No. 15 F and union of phallic fibers with three N. chromic sutures. (Fig. 13)

### III. OPERATIONS IN VOGUE

The operations most highly recommended at the present day are (1) denudation and suture according to the method of Sims, (2) flap-splitting with separate suture of bladder wall and vaginal mucosa, (3) suprapubic transperitoneal laparotomy.

All authors recommend the severing of those scars which fix the bladder to the pelvic bones. The usual method of approach is from the vagina. High and inaccessible openings may be attacked suprapubically usually by the transperitoneal route though occasionally the transvesical method has been advised. Kelly (loc. cit.) highly recommends opening of the peritoneal cavity from below in the treatment of fistula resulting from complete hysterectomy. The bladder becomes mobile as soon as the abdominal cavity is opened because the intraperitoneal part of the bladder (base and fundus) can now be drawn down at will unless adhesions limit its mobility.

What follows is not to be interpreted as advice to discard either the Sims operation or the flap-splitting method entirely because in competent hands, both of these procedures have given excellent results. Furthermore, patients are encountered in whom an otherwise simple and accessible fistula is situated in a very scarry vagina. An attempt to close a small fistula by the above-mentioned simpler techniques may be justified under such conditions in order to avoid the more extensive and difficult dissection necessitated by the bladder mobilization method. On the other hand, the mobilization method executed either from below from above or by the combined approach requires less special training and offers more prospect of immediate cure in a single operation. The added risk to life especially by the transperitoneal route although not excessive must be weighed in the balance. In complicated cases, however, the advantages of mobilization far outweigh any disadvantages or dangers which may be adduced against it.

Before describing the technique to be recommended, it is necessary to refer to the selection of the proper time for operation, preliminary treatment etc. which are of great importance.

### IV. PREPARATORY

*Time of operation.* As many fistulae heal spontaneously it is advisable to wait at least three months postpartum before interfering. This period is not wasted, as it allows the genital tract to involute completely and gives the neighboring tissues usually also involved time to heal. Clean-cut, postoperative fistulae commonly due to unrecognized injury to the bladder may be operated upon earlier than those resulting from sloughing or necrosis after operation. Usually 3 to 4 months must elapse before the exudate in infected cases has absorbed sufficiently to offer a promising operative field.

*Preliminary preparation.* The hair about the genitals should be kept closely clipped or shaven. Excoriations of the skin are healed by repeated application of thick zinc salve which is removed twice daily with olive oil. Raw encrusted areas on the vulva or in the

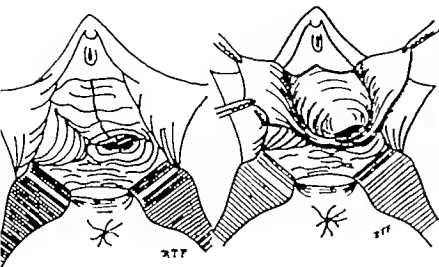


Fig. 4.

Fig. 4. Case 8. Vesicovaginal fistula resulting from radical operation for carcinoma of cervix. T-shaped incision through mucous membrane in dot and dash line. Fig. 5. Case 8. Anterior surface of bladder exposed by reflecting vaginal flaps outlined in Fig. 4. The deeper and lower portion of the bladder remained adherent and mobile fixed by the scar in the fornix.

Fig. 5

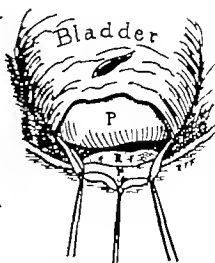


Fig. 6

Fig. 6. Case 8. Liberation of bladder base completed by opening the peritoneal cul-de-sac, thus permitting easy access and suture without tension. Compare with Fig. 5. P Peritoneum the upper part being peritoneum covering the bladder the lower being the posterior peritoneum of Douglas's cul-de-sac with traction sutures attached, R rectum.

gina should be touched up two to three times each week with five per cent silver nitrate. A hot sitz bath once a day is both soothing and cleansing. The urine should be kept acid by means of daily administration of four to six doses of acid sodium phosphate ( $\text{NaH}_2\text{P}_2\text{O}_4$ ) gr XV and bacteria free by xamethylinamine gr V to VII given three times daily. Bedridden patients may be made more comfortable if placed on a rubber ring and supplied with a gutter of oil-cloth, which drains off the urine and keeps the bed dry. This is preferable to vulvar pads which increase the local irritation.

**Anesthesia.** Ether or gas-oxygen narcosis except for minor interferences facilitates good exposure and permits of more rapid operating. **Position.** For vaginal work the usual dorsal lithotomy posture is most convenient. The knee-chest or Sims position tends to increase the distance between the fistula and the vulvar orifice. Suprapubic operation requires extreme Trendelenburg position.

**Armamentarium.** Such vaginal retractors as spades as the individual operator is accustomed to suffice for exposure. In addition to the usual instruments employed in vaginal plastic operations, the following are useful

Small curved and straight scissors, mouse-tooth and anatomical forceps commonly used in intestinal suture are of assistance, but are not indispensable. A bladder sound, soft rubber catheters, a Janet Frank syringe of 100 to 150 cubic centimeter capacity and small half curved needles should be ready. Occasionally a Young's prostatic retractor or a small Voorhees bag will prove of service in dragging down the fistula. The suture material should consist of fine (No. 0 and No. 1 plain and chromic) catgut and No. 2 twisted silk.

#### V OPERATION

Although the principles underlying all operations are the same, the description will be simplified by describing in detail the technique as applied to the three main varieties of fistulae: (a) simple fistulae (including vesicovaginal, vesicocervicovaginal and vesico-uterovaginal), (b) vesico-urethrovaginal (1) without, or (2) with complete destruction of the sphincter vesicae, and (c) inaccessible fistulae which necessitate suprapubic or combined vaginal and suprapubic approach.

**Simple fistula.** *Exposure.* After opening up the vagina with retractors the fistula should

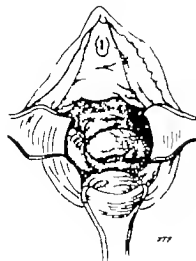


Fig. 7



Fig. 8



Fig. 9

Fig. 7 Case 9. Inaccessible fistula shown. The right of cervix partly exposed by deep retraction. The cervix could not be pulled down. The fistula is adherent to the left pelvic wall. Unsuccessful attempt at vaginal operation completed by suprapubic operation as shown in Figs. 8 and 9.

Fig. 8 Case 9. Position of the neighborhood of the fistula shown in Fig. 7 by the upper pubic transparent sheet. Both round ligaments and the right infundibulo-

pelvic ligaments ligated and cut. Peritoneum widely reflected, right uterine artery ligated far laterally, right ureter exposed, bladder mobilized up to site of fistula.

Fig. 9 Case 9. Continued from Fig. 8. Complete hysterectomy to afford easier access. The left adnexa are not removed. The lower third of the right bladder is mobilized by sharp dissection, the right bladder pole is freed, permitting exposure of the anal opening. Stomach of vagina pulled on by traction sutures.

be brought plainly in view by pulling the cervix downward. If the vaginal canal is narrow and contracted lateral incisions (single or double) through the perineum — as advised by Schuchard — increase the exposure. When the uterus is fixed it may prove of assistance to pass two or more guide sutures at the edge of the fistula.

**Incision.** Instead of advising denudation of the edges or circumcision of the fistula with flap splitting the writer prefers a longitudinal or inverted T-shaped incision, such as is practiced in cystocele operation. Unless the fistula is excessively large and thus greatly reduces the available amount of vaginal mucosa the incision should be made in the median line irrespective of the situation of the false opening. If a large fistula exists less mucosa is sacrificed by making the incision Y-shaped, the arms of the Y corresponding to the edges of the defect (Fig. 14). The mucosa should first be liberated in healthy tissue and only as the edges of the fistula are approached need special care be exercised. The vaginal flaps should be liberated as widely and com-

pletely as in the operation for vaginal interposition of the uterus. The liberation will usually prove easy if the scar tissue is reserved for the last.

**Liberation of bladder.** The next step is the full liberation of the bladder. Here also the neighborhood of the fistula is left untouched until some other portion of the bladder has been freed. Care should be exercised not to enlarge the hole by rough manipulation. If difficulty is encountered in freeing the bladder from bands or from the pelvic bones to which it may be adherent, it proves of service to insert the index finger of the left hand into the bladder through the fistula (then enlarging the opening if necessary) and to sever adhesions under the guidance of the finger in the bladder. If the adherence to the cervix or uterus is embarrassingly intimate the liberating incisions can be made through cervical or uterine tissue until the scar area has been freed. The bladder must be as completely mobilized as is practiced in vaginal interposition (Figs. 3 and 13). As soon as the bladder is freed it contracts and can be readily ele-

vated Only rarely will the ureters be encountered except in those cases in which the fistula is situated far laterally in the fornix. If the field is well exposed the ureters are readily avoided. In cases of this nature it will often prove easier to operate by the combined method to be described below rather than to grope blindly in an inaccessible and bloody cavity.

**Suture** After the bladder is freed all bleeding points should be carefully secured. Interrupted Lembert like sutures of fine chromic catgut passed through the muscular coat at one half centimeter intervals are used to close the bladder defect, but no sutures are tied until all have been placed. The first and last suture should be passed one half centimeter beyond the angles of the hole. When the destruction of adjacent structures has been slight and fascial tissues are available (8) a further repair such as is practiced in cystocele operation may be employed (Fig. 13) approximation by suture of the pubocervical ligaments *PC*). The operation is completed by closure of the vaginal flaps with interrupted silk sutures.

In dealing with vesicocervical or vesico-uterine fistulæ openings in the cervix or uterus may be freshened and closed by suture as a final step before the vaginal mucosa is approximated or they may be left untreated as they heal spontaneously.

The above operation can also be employed when the fistula has resulted from injury to the bladder during hysterectomy. The same method of exposures should be used. After exposure of the anterior part of the bladder if the fistula is at or near the fornix (after complete hysterectomy) the peritoneal cavity should be widely opened at the fornix, as advised by Kelly (loc. cit.). This enables the operator to pull the posterior part of the bladder downward and forward. The sutures can now be passed without difficulty (Fig. 6). The peritoneal opening may be closed by a few sutures or may be drained by inserting a wick of iodoform gauze (to be removed after seven days) which should not come into contact with the line of suture.

**Vesico-urethro-vaginal fistulæ without complete destruction of the sphincter vesicæ** Unless

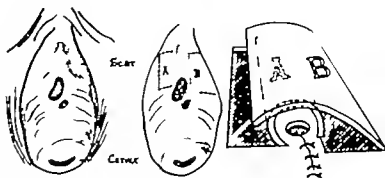


Fig. 10

Fig. 11

Fig. 12

Fig. 10 Case 15 Complete destruction of urethra (two vesicovaginal fistulae below area of scar)

Fig. 11 Case 15 Denudation and uniting of fistulae outlined in dots. Vaginal flaps for reconstruction of urethra indicated in broken lines. The base of both flaps A and B are toward the patient's left.

Fig. 12 Case 15 Diagram showing the method of fixation employed on the liberated flaps outlined in Fig. 11. The fistulae have been united and repaired except for a small opening left at the upper angle of the bladder injury. Flap A has been turned inward to form a tube lined with mucosa. Flap B is drawn across so as to cover not only the raw outer surface of flap A but also to close in the vaginal defect left by reflecting A. At a later stage the new tube was united to the bladder opening.

the opening into the bladder is small and far anterior it is preferable to liberate the bladder completely as in the preceding variety of cases extending the incision well up toward the external meatus. In simple cases the bladder and urethra are then sutured over a No. 12 or 15 French rubber catheter with interrupted sutures of chromic gut, which grasp the muscular but not the mucous coat. At the bladder neck the sphincter fibers together with a delicate but distinct fascia are then approximated by two or three interrupted sutures just as the sphincter ani is caught in the operation for complete tear of the perineum after the rectal defect has been repaired (Fig. 13). The torn and retracted sphincter of the bladder must be sought for close to the edges of the pubic ramus. This region is very vascular hamostatic sutures often being required to stop the severe venous hemorrhage.<sup>1</sup>

If the distal part of the urethra has been much mutilated or has entirely disappeared little effort should be expended in restoring the urethral canal because continence de-

<sup>1</sup> Searching for the fibers of retracted cervical sphincter it proves of service to pass traction suture about centimeter from the pubic ramus at the level of the neck of the bladder. When this guide is pulled upon the stronger and deeper fibers are brought into view.

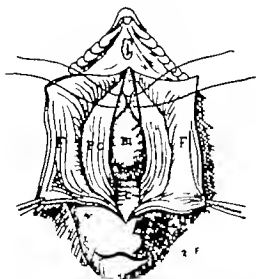


Fig. 3. Case 8. Exposure and suture of incompetent sphincter muscle. Vaginal flaps (F) have been liberated and retracted. The bladder (B) has been freed and pushed upward, exposing the supravaginal part of the cervix (C). On each side the pubocervical ligaments (P-C) have been exposed. The sphincter fibers are shown partly approximated by traction on two angled sutures.

depends solely upon the sphincter fibers. Construction of a new canal greatly lengthens and complicates the operation with little more than cosmetic effect, even if union results.

*Vesico-urethrovaginal fistula with complete destruction of the sphincter vesicae.* This fortunately rare variety usually is characterized by large defects and serious mutilation with extreme distortion due to scar tissue formation. The entire base of the bladder has often disappeared together with the urethra. The upper thickened and inflamed wall of the bladder commonly prolapses through the hole. One or both ureteral openings may show along some part of the circumference of the defect.

The writer has never been fortunate enough to encounter such a case before it had been subjected to one or more previous operations.

In the three cases he has operated upon, all the tissues were almost hopelessly mutilated perhaps more by the previous operations than by the primary injury.

In one of the cases by repeated plastic operations the bladder opening was reduced to a size just ad-

mitting a No. 15 F catheter. In the one (Case 15) a new urethra was constructed with vaginal mucosa flaps and at a later operation joined to the bladder opening. Continence was somewhat improved by submucous injections of hard paraffin around the neck. A pressure pessary (such as Kelly<sup>4</sup> describes) then served to give some control after the perineum had been repaired.

The second case (Case 14) was less successful, as every attempt at flap formation failed because of the invariable occurrence of necrosis. This patient refused to consent to vaginal interposition, as she desired to have a child before being sterilized.

The third case (Case 16) resulting from puerperal sepsis with an extensive defect and much operative loss of tissue was treated in the following manner. By repeated operations the bladder was freed from the pubic bones, the opening being reduced to small size. After this reduction had been accomplished, a bladder sound, passed through the opening, was then forced outward toward the skin above the region formerly occupied by the clitoris. The skin was incised and the bladder wall (drawn out into funnel shape) was sutured to the skin. Later the old bladder opening in the vagina was completely closed. A belt with pad applied over the new urethra gives some degree of continence but proved too troublesome for the patient to wear. Further operation may improve the control. (Figs. 14, 15, 16, 17.)

These three operations were planned in the hope of utilizing a new formed urethra to give some degree of control. On the whole the results were as disappointing as those described by other operators. In the future the writer proposes to use in modified form a procedure which has been previously employed by Freund (9) and others to close large defects by means of the interposed uterus. In the present instance the uterus is to be employed not to close the gap but to take the place of a pressure pessary in re-establishing continence.

The operation may be executed in the following sequence: (a) liberation of the bladder; (b) transposition of the uterus through the anterior cul-de-sac—(1) *per vaginam* or if this fails (2) by the suprapubic route; (c) closure of the bladder defect down to a small opening which is to functionate as the urethra; (d) interposition of the fundus uteri into the vesicovaginal space.

The operation should be limited to desolate cases with large defects and especially to

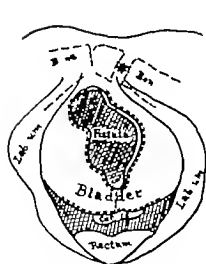


Fig. 14.

Fig. 14. Case 16. Diagram of enormous vesicovaginal fistula with destruction of sphincter and urethra after pubiotomy. Asterisk shows space between ununited ends of ramus. Outline of incision indicated in broken lines.

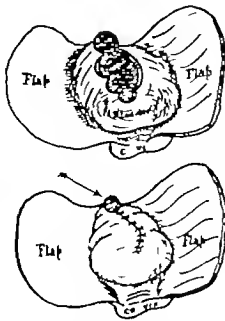
Fig. 15.  
Fig. 16

Fig. 15. Case 16. Diagram showing liberation of bladder after reflection of vaginal flaps illustrated in Fig. 14.

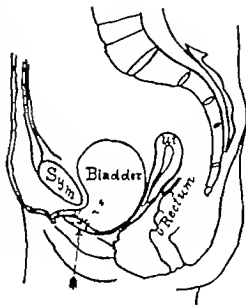


Fig. 17

Fig. 16. Case 16. Diagram showing suture of fistula except at its upper angle (arrow) (See Figs. 14 and 15.)

Fig. 17. Case 16. Diagrammatic sagittal section showing formation of new urethra above the region of the clitoris. New canal in shaded portion. Situation of a normal urethra indicated by broken line. Arrow head at site of opening seen in Fig. 16. This opening was closed after the patency of the new canal had been assured.

cases in which the entire sphincter apparatus has been destroyed. It should be the operation of choice and take the place of complicated plastic repairs which even if they prove anatomically successful fail to restore continence.

**Operation.** *Liberation of bladder.* The vaginal mucous membrane should be separated from the bladder along the edges of the defect, the incision extending downward toward the cervix (forming the base of a Y). With one finger in the bladder the liberation of this viscus should be attempted preferably beginning the separation in the least adherent portions. It usually becomes necessary to detach the bladder from one or both ramus to which it has become adherent. The hemorrhage is profuse and persistent. As the bleeding spots are located in dense scar tissue hemostatic sutures are usually required.

*Transposition of the uterus.* If the anterior peritoneal reflection can be reached and opened an attempt should be made to draw

the uterus into the vagina. Should this effort be successful the operation is completed by narrowing the bladder defect by means of suture down to a small opening just admitting a No. 15 F catheter. The uterus is then interposed between bladder and vagina, so that the top of the fundus projects to or beyond the new opening. The vaginal flaps are sutured over the uterus, lateral openings for drainage gauze being established between uterus and vaginal flap. The tubes must of course be ligated.

*Transposition of the uterus by the supra pubic route.* If it is impossible to reach to peritoneal reflection if the liberation of the lateral parts of the bladder fails because of too dense adhesions and scar or if the hemorrhage proves uncontrollable, the vagina should be tightly packed with gauze and the abdomen opened suprapubically. In steep Trendelenburg position the uterus is drawn upward and the vesico-uterine peritoneal fold widely opened. The round ligaments may be cut between ligatures to give freer

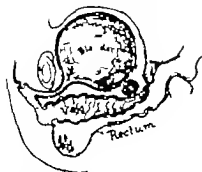


Fig. 8 (sag.) Sagittal section showing bladder stalk projecting partly in the bladder, partly hidden and virtual tumor resulting from closure of escovaginal fist.

exposure. The bladder can now be freed more readily. At times it may prove necessary to doubly ligate and cut one or both uterine arteries in order to liberate the ureters and bladder angles. All hemorrhage is now controlled by ligature or suture.

After removing the vaginal packings the uterus (first ligating the tubes) is pushed down into the vagina, the incision in the vesico-uterine peritoneum is sutured, and the abdominal wound closed. The operation is completed from below in the manner outlined in the previous paragraph. This type of operation is of course as previously stated to be strictly reserved for the severest cases in which no muscle tissue remains at the neck of the bladder. The operation is long and severe.

Should the desired degree of control not be obtained added pressure may be exerted upon the uterine pelotte by subsequently narrowing the vagina and increasing the height of the perineum.

**Inaccessible fistula.** In some cases the fistula is situated so high, the scar formation is so dense or the bladder is so adherent that it proves impossible to reach the defect *per vaginam*. In other instances uncontrollable hemorrhage is encountered.

Under these circumstances it is preferable to attack the trouble through a median suprapubic incision. An effort may be made to preserve the uterus, proceeding as pre-

In one instance of emergency operation the bleeding from the vesical peritoneal veins could not be controlled by any means except by tightly sewing several layers of gauze to the bleeding area. One end of the gauze was drawn not through the vagina and the pack removed as the rectal de-

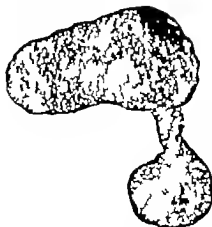


Fig. 9 Photograph of tumor shown in preceding figure.

viously described by incising the vesico-uterine fold of peritoneum. The bladder is then freely mobilized the hemorrhage controlled and the fistula repaired by suture. If the technical difficulties are insurmountable complete hysterectomy with or without removal of the appendages, affords added facility in the liberation of the bladder. When the fistula has been exposed and the bladder fully liberated gauze for drainage should be drawn into the vagina *before the bladder is sutured* (in order to avoid disturbing the line of suture later). The gauze should not touch the line of suture. The bladder hole is closed with a few interrupted sutures of fine chromic gut. The pelvic peritoneum is then closed so as to extra-peritonealize the field of operation. The sigmoid may be attached over the suture line as an additional safeguard. The abdominal wound is closed without drainage (Figs 8 and 9).

#### VI AFTER TREATMENT

**Permanent catheter.** A light weight rubber catheter should be inserted into the bladder and fastened to the meatus by a suture reinforced by adhesive plaster. The catheter drains off the urine and keeps the bladder in a permanent state of contraction for at least 8 days. The rectal vessel should be graduated so that any stoppage of flow is at once noted and corrected. It is the writer's practice to instruct the patient to watch the flow and to inform the nurse as soon as an

obstruction occurs. By slightly pulling the catheter outward or pushing it inward the stoppage is usually overcome. If clots or clumps of mucus cause obstruction introduction of  $\frac{1}{2}$  to 1 ounce of sterile solution by means of a syringe will clear the line.

The bowels should be kept constipated for 5 to 8 days. Early straining at stool may reopen a fistula.

**Leakage.** Should leakage of urine through the vagina be noted the operation is not necessarily unsuccessful especially in those cases in which the bladder has been freely mobilized. The permanent catheter should be kept in place for at least 14 days as healing may yet take place. In one instance (Case 9) this measure was crowned by success after 28 days.

Cotus should be interdicted for at least 8 weeks. One patient (Case 2) on the fifteenth day left the hospital cured. She returned two days later the fistula having reopened as the result of cotus. A second operation had to be performed.

#### VII DIVERTICULA AND STONE FORMATION

In three cases (Cases 4, 5, and 7) all post operative in origin, the fistula because of the distortion due to scar formation had produced narrow funnel-shaped diverticula of the bladder. These were unrecognized at the time of operation because the flap-splitting method of repair was employed. In Case 7 the first operation was unsuccessful the leakage persisting. At the second attempt at closure the bladder was fully liberated the diverticulum was exposed, recognized and excised and the defect sutured. She has remained well (3 years).

In the two others (Case 4 and 5) healing took place but repeated formation of soft vesical calculi occurred. These at once re-formed after removal through a Kelly cystoscope. Search for an encrusted suture proved negative. cauterization of the granulating area after removal of the stones was unavailing.

In the first case an incision into the vesicovaginal septum revealed a collarbutton-shaped stone the smaller portion being embedded in the extravascular diverticulum, the head projecting into the bladder. A narrow isthmus connecting the two enlargements the diverticulum was thoroughly cauterized with pure carbolic acid as excision was impossible.

An intractable cystitis complicated the condition and later necessitated vaginal cystostomy with drainage (Figs. 18, 19) for removal of the intra vesical stone and treatment of the cystitis.

In the second case a permanent cure has not yet been effected, because the vesical calculus was removed just before operation and therefore the sole guide to the small diverticulum was lost. Exploration of the vesicovaginal septum failed to reveal the diverticulum. As soon as the stone has re-formed another operation will be undertaken with the attached stone *in situ*.

#### VIII CLOSURE OF MINUTE FISTULÆ

The closure of very small fistulæ sometimes give as much or more trouble than the repair of large defects. The writer succeeded in closing a small opening which persisted after the closure of a large hole and which did not heal. The method employed was the following. The bladder was kept distended by means of a continuous current of water introduced through one channel of a catheterizing cystoscope. Through the other channel a wire insulated except at its tip was passed for a short distance into the intravesical opening of the fistula. The d'Arsonval current was applied for 10 seconds as recommended by Beer (10) for bladder papillomata. The fistula has remained permanently cured.

#### IX SUMMARY

Comparison of those cases of bladder injury which heal spontaneously with those which form permanent fistulæ shows that neither the size nor situation of the defect is of as much importance as the fact that in the former the bladder is free to contract and that broad tissue planes are mobilized.

By applying these observations to operative repair more uniformly successful results may be anticipated.

Full liberation of the bladder should be practiced in every case before attempting to repair the injury. This injunction should be obeyed especially by the occasional operator.

Since the completion of this paper the patient has also been operated upon. A suprapubic cystostomy was performed, the intravascular portion of the stone removed, and the diverticulum, bulged part of the stone liberated by incising from about 34 centimeters behind the internal sphincter backward between the urethral openings for a distance of 14 centimeters. The stone was dislocated into the bladder. As the diverticulum could not be reached because it was in intimate contact with the rectum and stump of the vagina, the post-scar bladder incision was sutured in such a fashion as to make the opening large and give it free communication with the bladder. This case will be published later date.



who is not intimately acquainted with the minute and precise technique of the Sims and the flap splitting operation

With slight variations the above method of procedure is applicable alike to simple fistulae (vesicovaginal, vesicocervical vesico-urethrovaginal) inaccessible fistulae and fistulae complicated by partial or complete destruction of the bladder sphincter

When the bladder sphincter is completely destroyed plastic construction of a new urethra proves unsatisfactory After repair of the defect the uterus may be interposed into the vesicovaginal septum to restore continence

Depending upon the local conditions encountered the vaginal suprapubic or combined method of approach may be practiced

When a leak develops the use of the permanent catheter should be persisted in far longer than is customary as healing may still take place as late as the fourth week

By fully liberating the bladder as a matter of routine diverticula (which later may cause stone formation) cannot escape notice. The closure of minute fistulae may be attempted by intravascular cauterization with the d'Arsonval current through a water cystoscope

## CONCLUSIONS

1 Spontaneous healing of vesical injuries takes place most readily when the bladder is fully mobilized, and the tissue planes are given an opportunity to glide one upon another

2 The process of spontaneous repair is assisted by keeping the bladder in a state of contraction by means of a permanent catheter

3 Bladder suture is of secondary importance if the above principles are utilized in operative intervention

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THE SURGICAL SIGNIFICANCE OF THE CYSTICODUODENAL AND THE CYSTICOCOLIC LIGAMENTS<sup>1</sup>

BY WELFR VAN HOOK, A.B. M.D. CHICAGO

THE purpose of this paper is to direct attention to the surgical importance of those variants of portions of the great hepaticogastric ligament which take origin in the gall bladder and in the one case pass to the duodenum and in the other case run over to the colon.

Permit me to present quite briefly the two observations forming the basis of the paper.

CASE I. A strong man about 25 years of age in good health except that he had had several attacks of acute cholecystitis with the colic that is usually associated with temporary partial obstruction applied for surgical treatment.

An operation was undertaken a short time after an acute attack. The temperature had been normal for several days, the tenderness was slight and there was no pain, the patient being able to go alone to the hospital from his out-of-town home.

On opening the abdomen the gall bladder was found at the usual site and there were no adhesions about it at any point. But it was found to be attached to the colon by a fold of peritoneum, a perfect example of *ligamentum cysticocolicum*.

This ligament extended from a point upon the gall bladder about one-third the length of the gall bladder from the apex of the sac downward to involve the lower part of the receptacle and the cystic duct. It passed over in an easy fold to be inserted into the colon wall joining with the mesocolon and spreading out upon the bowel itself. The tissue of the ligament was not infiltrated, showed no signs of inflammatory origin or attack. On the contrary it was as flexible and as easily torn as let us say the meso of the vermiform appendix.

Upon opening the gall bladder with extreme care as to protection of the abdomen from gall-bladder contents a few drachms of bile, a little thicker and darker than usual were evacuated. This fluid showed no signs of purulent or serous admixture and contained no flocculi or detritus. There were no stones and the cystic duct was found by the probe to be quite patent. As the patient was not fleshy the common duct could be palpated together with the accompanying structures but no stones served to differentiate it by palpation.

The walls of the gall bladder showed no sign of inflammation past or present other than a rather deep reddening of the mucosa.

The influence of this ligament on the patient's health seemed manifest when the gall bladder was



Fig. 1. *Ligamentum cysticocolicum*. Case 1.

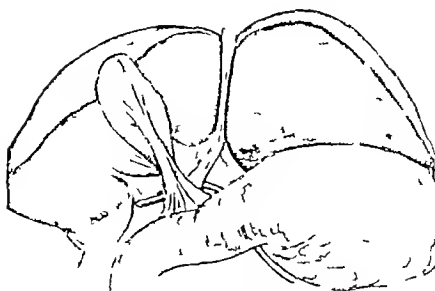


Fig. Cysticoduodenal Ligament Case

used with the liver and the gallbladder was drawn down into the abdominal cavity. It was demonstrated that dependent on the position of the colon the gallbladder hardly showed such a view that the gallbladder of the cystic duct. The gallbladder was divided partly by the fingers and partly with the scissor, the small blood vessels being ligated. Careful drainage of the gallbladder with a rubber tube and the neighboring peritoneum with gauze was followed by closure in the usual manner. Notwithstanding the technical difficulty was considered to suggest an unhappy outcome of the operation. Nevertheless peritonitis of the severest kind set in and the patient died in about thirty-six hours.

Limited postmortem examination was made by Dr. Walter Stenberg who reported that a violent peritonitis with but little fluid exudate was responsible for the termination of the case that there was no blood or any foreign body in the abdomen and that no injury or rupture of any viscous other than the operative wound already spoken of could be found. It was concluded that the fatal termination was due to an infection of the peritoneum at the site of the wound of the gallbladder which do but less was the source of the extraordinarily virulent bacteria.

The opportunity to make the full inspection of the upper abdomen showed that there was present no other cause for the obstruction of the gallbladder than the gallbladder and the traction upon that tract by the colon, which was attached to it by the unusual cysticoduodenal ligament.

CASE. M. W. aged 40 years had suffered for several years from recurring attacks of

gallbladder colic and inflammation. These attacks were moderately severe lasting a few hours and were associated with slight elevation of temperature. Tenderness, greatest when the distended and palpable gallbladder was blocked during an attack, persisted throughout the interval between exacerbations. The diagnosis of gall-stones was tentatively maintained by the very skilled attending physician.

On inspecting the gallbladder and the surrounding structures, some light adhesions were observed between the lower part of the body of the gallbladder and the duodenum. Their presence was interpreted as testimonial to the diagnosis of chronic and recurring gallbladder inflammation.

Attention was then directed to another structure uniting the gallbladder to the duodenum. This structure was a true cysticoduodenal ligament.

It took its origin upon that face of the gallbladder wall that looks toward the pylorus and as the gallbladder was held up it descended in an easy curve to a broad insertion over the duodenum, extending about half way around the circumference of that organ.

This fold was composed of two plates of peritoneum with a filamentous layer of loose and slightly fat-laden connective tissue between them. It was divided partly by tearing and partly by cuts with the scissors. It was carefully noted that at no point was there evidence of an inflammatory element. The production of this structure there were no contracted or tough band-like elements of fibrous tissue. No was there any myeloid element in the ligament but as the tissue was pulled upon,



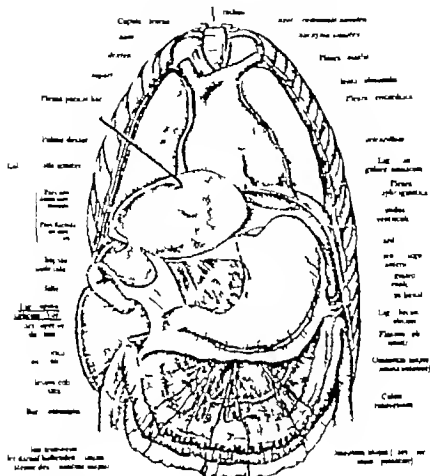


Fig. 4. The well marked ligamentum hepatocolicum. (From Toldt.)

classical atlas of Toldt showing clearly an example of one of these ligaments. Then the study of Foerster yielded the following exact description:

In certain rare cases the gall bladder is entirely suspended from the liver by a peritoneal fold of ligament (mesocystic) and enjoys a wide mobility distinct from partly fixed meso while dominating the surface of contact with the liver.

The relations of the anterior face of the gall bladder in front of the transverse colon, in the region of the duodenum, to the meso to which it may be united by side tal adhesions or even by a peritoneal meso the *mesocolic* ligament.

Sometimes indeed the gall bladder and the transverse colon are contained in a peritoneal meso called the *mesocolic* ligament. This ligament, which is but a part of the hepatocolic ligament that is to say of the distal part of the gastro-

hepatic ligament is inserted above upon the lower pole of the gall bladder from the neck as far as the beginning of the fundus and descends below upon the anterior face of the duodenum and the distal angle of the colon. The lower face of the gall bladder then finds itself deprived of peritoneum up to the vicinity of its borders and is separated from the colon solely by cellular tissue. The ligamentum cystocolicum is met with once in four cases according to Brice and Jonnesco once in seven times according to Raynal. In some exceptional cases observed by the preceding authors it could be with (was equivalent to) a cystic mesentery (meso-cystate) inasmuch as the gall bladder was suspended in the midst of an hepatocolic ligament.

Hans Kehr presents incidentally a picture of one of these ligaments although I am not aware that he attributes to the structure any rôle in the causation of disease.



tions due to the action of tones scars and valves. In the latter category are to be found the obstructions caused by compression or constriction and by angulation.

Now it is with the phase of angulation of the bile-duct that we are especially concerned. With the angulations caused by inflammatory or malignant action we have nothing to do. And similarly we must say but little of those angulations that are caused by the unusual relations that may subsist between the duct and the hepatic artery.

The normal angle formed by the gall bladder with the longitudinal axis of the body is pronounced. Poirier calls attention to the fact that the gall bladder has too frequently been supposed to point as it were straight forward whereas the body of the sac is well to the right of its outlet. When the gall-bladder is fixed by adhesions too far to the right there may be partial obstruction.

While it seems probable that under ordinary

conditions the emptying of the gall bladder may be compromised in no degree by the presence of a ligamentum cysticoduodenale or a ligamentum cystocolicum yet when there is displacement of the colon or duodenum the ligament may cause angulation of the duct by traction. Intermittent angulation may easily occur by the overfilling of the colon with gas. Practically the same thoughts are valid with reference to the ligamentum cysticoduodenale.

It is obvious that as in the instances here reported this angulation may cause localization of bacteria in the gall bladder with the classical symptoms of cholecystitis.

It is to be hoped that other surgeons will contribute observations upon these important structures of which the rôle in surgery may prove to be of as much importance as the peritoneal bands and folds now so frequently noted as being discovered in the ileocecal region.

# DEPARTMENT OF TECHNIQUE

## WIRE-BANDING FOR FRACTURES

WITH THE DESCRIPTION OF A NEW TOOL

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AND

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THE wire banding method which we are about to describe is a scheme to avoid the disadvantages of the Parham band. Mr Robert Milne devised the first fracture banding mechanism which could be called efficient

Parham of New Orleans went much further we have used the Parham band in many cases with great satisfaction. It has the disadvantage however of leaving in the tissues too much foreign material and of creating a point of least resistance in the bone even if the band is imbedded as we have found it to be in the majority of the cases examined some months or years later<sup>1</sup>

One case, banded ten months ago by one of us illustrates this finding clearly (see Fig. 1)

It seems reasonable to follow the rule that all bands should come out after union has taken

In the case of Dr. William E. Faulkner the band was not imbedded but showed gliding grooves in the bone and diameter within this groove definitely less than that of the rapidly growing child femur

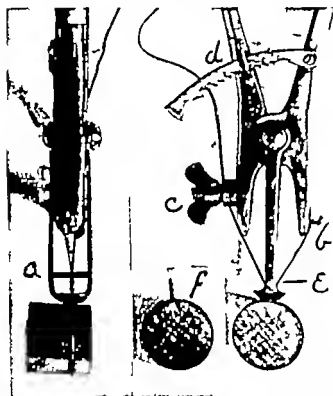


Fig. 1. The strand of wire used has a loop (braided) at one end. The wire is passed about the bone, and the ends passed crosswise through the oval smooth edged hole in the tip then up on either side the cross-bar (a). The looped-end then goes over the hook (b) the free end is clamped by a camlock under the wing nut (c). The handles are then closed until the wire is fairly snug. The tension is held by the ratchet (d). Then the whole instrument is twisted, the smooth hole in the tip makes the spiral close and the cross-bar (a) crowds the turns down close. The wires are cut at the level of (e). The loop is flattened over onto the bone. How close the wire-band is drawn may be seen from the insert at (f).



Fig. 2. Femur banded ten months previously. Re-fractured exactly at point of banding by fresh but slight accident. The band is clearly shown to have been imbedded but it nevertheless constituted a point of least resistance.



place and I have recently adopted this rule in handling fracture cases. If a vertebra is secured by operation to move the load can be eliminated if we can overcome the usual antiseptic irritation and possible non-union by using a negligible bulk of metal—just a band of thin strong wire—the gauge is 18.

The use of wire is not new. But the method used have been found mechanically inefficient. The horse manufacturers and the packers and balers of various goods (from hay to old newspapers) have used wire banding instruments. The instrument which came nearest to meeting our need was the wire twister used to fasten rubber hose to metal end and joint. While this instrument most efficiently answers the purpose for which it was designed, it has proved inadequate for wiring fractures for such a twister leaves a V below the twist that impairs the fixation of rigid object.

Our problem, therefore, was first to eliminate the V and second, to secure tension without nipping the wire and we have succeeded in making a twister which fulfills both requirements. The instrument shown will twist wire down flat

to the bone surface. The wire can be twisted one and one half turns after reaching the point of final fixation.

We use phosphor bronze wire, silvered (although that is probably entirely unnecessary) of gauge 18 to 20 Brown & Sharpe.

On wire does the work of a Parham band in most cases. Two wires will do more than any Parham band possibly can, and will leave an incomparably smaller cross section of metal about the bone.

Although the method has been used clinically in a few cases it cannot be said to have been proved out clinically as yet. It has worked well so far.

Its application as a substitute for the Parham band is fully justified.

Just how much can be done in the fixation of fractures by wire passed through drill holes and brought taut by this instrument, is still an open question, although it has worked well on the few cases in which we have used it.

The instrument devised has been presented before the Boston Surgical Society and we wish to present it in print so that others may use it and judge as to its practicability.

## THE TREATMENT OF BURNS AND GRANULATING SURFACES WITH PARAFFIN-FILM PREPARATIONS

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THE way of paraffin film treatment of burns and granulating wounds sprang from the sensational account of the secret French preparation and line much used in the war now going on. American surgeons returning from the war in France have given glowing accounts of the wonderful results from the use of ambrene. This led to two or three American products being placed on the market. All have followed the French example of keeping the formula a secret. It is one of the disadvantages of secrecy that we do not know what attempts have been made to secure the best possible preparation and in the absence of this knowledge it is reasonable to suppose that the secret preparation is capable of modifications which might add to its improvement.

To meet the demand for a non-secret ethical preparation quite an investigation of the subject has been made by Dr. Torald Sollman which

is described in an article on the subject entitled "Suggested Formulas for Paraffin Films" which appears in the *Journal of the American Medical Association* for April of this year some extracts of which I have incorporated in this paper.

The treatment of burns and granulating wound surfaces with paraffin preparations has proved to be a distinct advance in surgery and any surgeon who has employed this method of treatment cannot but realize that the results obtained are much superior to those obtained by any other procedure.

Wounds cicatrize in one-third to one-half the time. The scar tissue is less dense and more flexible and skin grafting is comparatively not often required. Should skin grafting be thought advisable it will be found that under the paraffin film application, these grafts will develop much more rapidly than by any other known method.

The action of the paraffin-film application

upon granulations is largely mechanical. On cooling the film contracts and exerts a suction action thus inducing an active hyperemia. By keeping the wound airtight, and by acting as a splint or scaffolding to the granulations it promotes active proliferation of the newly formed tissue cells.

Many formulas or combinations of paraffin with other substances have been suggested and used in this country as well as abroad. All the preparations including ambrine have paraffin as a base and Dr Sollman in his experiments with paraffin mixtures used 28 different ingredients including petrolatum Venice turpentine, Japan wax olive oil, yellow beeswax castor oil spermaceti resin cocoa butter liquid paraffin and the different varieties of asphalt. As compared with ambrine (which he states contains 96 per cent of paraffin) he could note no marked differences as between any of the above combinations. The different varieties of paraffin on the market have melting points varying from 48° to 53° C and the various commercial brands differ in their physical properties such as melting point, hardness and flexibility. It was found that samples melting close to 50° C are to be preferred. Aside from melting point, flexibility seems to be one of the most important features.

Most paraffins found on the market are too hard to use without incorporating some softer substance to modify and make them more flexible. The admixture of wax and resin with paraffin seems to modify it suitably for the purpose of a film dressing and Dr Max Kahn, biochemist of the Western Pennsylvania Hospital, has suggested that 2 or 3 per cent of paraffin oil added to melted paraffin renders it much softer and much less liable to crumble upon cooling.

Dr A. J. Hull of the Royal Army Medical Corps, states that treating paraffin with superheated steam seems to change its character in that it becomes softer and more flexible. He also states that the results attained with its use as a dressing in burns seem indistinguishable from those of ambrine. He further states that even better results are obtained by the addition of certain antiseptics and stimulating substances. The wounds become clean more rapidly pain decreases and the offensive smell associated with ambrine dressings is avoided. The formula we first began using at the Western Pennsylvania Hospital was composed of 70 per cent of Gulf wax paraffin 20 per cent of white beeswax (U. S. P.) and 10 per cent of resin.

With this product we could obtain all the effects of ambrine but it was not so flexible and had a

marked tendency to crumble. To obviate this, Dr Kahn suggested adding a per cent of Russian mineral oil to the formula. Further experiments showed that the addition of a small quantity of resorcin seemed to obviate the offensive smell before referred to as following the use of ambrine.

It was then thought that the addition of some substance to the formula to promote the more rapid proliferation of the epithelial cells would prove a benefit. We have used two substances for this purpose scarlet red and sudan III suggested by Dr Kahn. Sudan III seems preferable as its action as a stimulant of epithelialization is found to be more pronounced. Sudan III is a diazo compound of the aniline series having the composition  $C^{12}H^{14}N^4O$ . It is soluble in alcohol chloroform xylol and essential oils.

Upon the injection of certain dyes like sudan III or scarlet red pathologists have observed a certain stimulation in the proliferation of epithelium. This active proliferation has been ascribed by Fischer to an attraction for the epithelial cells. He called the dye therefore, an attractin. The changes are primarily in the connective tissue and resemble the changes produced by chronic inflammation. When sudan III or scarlet red is injected immediately below the epithelium the connective tissue first loses its reaction to acid dyes. Following this the epithelium begins to proliferate. The epithelial proliferation is confined to the area in which the connective tissue has undergone its modified reaction to acid dyes. The epithelium retains its normal characters but the mitotic figures may be observed and pearl formation is common. The epithelium does not invade regions where preliminary changes in connective tissue have not occurred. The results obtained by sudan III administration are similar to the effects produced by X rays except that in the latter instance the epithelial cells have a tendency to invade (after a time) regions where the tissue is still normal and thus metastases may be formed as in all malignant neoplasms (Wohlbach Hertzler).

The formula of the wax preparation we have been using at the Western Pennsylvania Hospital for the last four or five months and from which we have attained most excellent results consists as follows:

Paraffin (Gulf Refining Co. Pittsburgh)	70 0 gm.
Liquid petrolatum, U. S. P. (paraffin oil)	3 0 cc.
White beeswax U. S. P.	10 0 gm.
Resin	7 0 gm.
Resorcin	0 5 gm.
Sudan III	0 05 gm.
Alcohol (95 per cent)	10 0 cc.

The paraffin and the oil are melted in a casserole over asbestos board the direct fire being used. The resin and the sudan III are dissolved in the alcohol and added drop by drop to the melted paraffin with constant stirring. The mixture is now heated until all the alcohol is evaporated. The beeswax is stirred in until melted heat being used if necessary. Then the resin is added and mixed in thoroughly while the casserole is being heated. The mixture can be poured into molds and cooled.

Do not melt the resin by itself over a hot fire as high organic acids of a very irritating character are produced which occasion pain to the patient and irritation to the wound. Subsequently the wax cake should always be remelted in a double boiler if the boiler containing the wax be placed immediately over the fire or hot plate some decomposition of the resin in the mixed formula may take place with all the objectionable result mentioned.

#### TECHNIQUE OF APPLICATION

After melting the wax preparation in a double boiler it is usually applied in one of three ways:

1. Directly with a suitable brush.
2. Sprayed on with a spraying device (like an atomizer) the instrument being kept at the proper temperature by an electric coil surrounding the parts containing the wax.

3. Saturating gauze strips or pieces of sheet cotton with the melted wax preparation and immediately applying the same to the surfaces to be covered. Sheet cotton specially prepared for this purpose has been placed on the market under the name of redintol and is very well adapted for the purpose. After the first layer of wax is applied by one of the above methods, a piece of gauze or thin layer of cotton is placed over this application and this is again painted with wax so that the gauze or cotton is firmly embedded in the wax. Some loose cotton is now applied over this and the part bandaged.

When the wounds are very painful or sensitive and it is not practicable to apply the first layer with a brush the wax may be applied by one or another of the methods mentioned. Incorporating a layer of gauze or cotton between the two layers of wax enables one to remove the whole dressing in one piece when desired.

When severe burns of recent occurrence are to be dressed it is well to puncture all blebs and remove all loose dead skin that can be done without giving added suffering before applying the wax dressing. At the next dressing it will be found that quite an amount of serum has

collected beneath the wax. This should be gently mopped away with cotton sponges together with the removal of all necrotic tissue. Before reapplying the wax it is necessary to dry the surfaces with hot air otherwise the wax will not stick to the surface. This can be done with an electric hair drier commonly used by hair dressers.

To get the best results burns should be redressed daily. The gentle cleansing of the eroded surfaces, as well as the surrounding skin of all discharge and necrotic tissue is important. This is probably best accomplished with the cotton sponge saturated with ether being careful not to rub the granulating surfaces. Here let me say that you should also be careful that no flame be near at hand. An electric hot plate is to be highly recommended for heating the wax.

After the wax is melted in the double boiler it should be cooled to 120° F when it may be applied with little discomfort. An ordinary thermometer placed in the boiler containing the wax will serve as a guide. After some experience the dresser may not require the use of the thermometer to determine the proper temperature. By applying a film of melted wax on the back of the gloved hand the dresser can obtain a good idea of the temperature from the rapidity with which the wax solidifies and also by the heat tactile sensation of the hand. However we have yet to see any burns resulting from applying melted wax from the double boiler.

It is certainly wonderful what comfort the properly applied wax dressing affords to patients suffering from painful burns and it is still more wonderful to note the rapidity with which the healing process proceeds.

Although it requires considerable time to cleanse properly the burned areas preparatory to renewing the dressings this cannot outweigh the advantages, such as the comfort it affords the patient the shortening of the period of convalescence, the rapid promotion of epithelialization and the lessened tendency to dense scar formation.

With reference to the paraffin film there may be improvements at present it is probably the most important addition to surgery in the treatment of burns and granulating surfaces.

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# A PRELIMINARY REPORT ON THE SIMULTANEOUS USE OF INDIGO CARMIN AND PHENOLSULPHONEPHTHALEIN TESTS IN SURGICAL DISEASES OF THE KIDNEYS<sup>1</sup>

BY ANDERS PETERSON M.D. LOS ANGELES, CALIFORNIA

IN 1903 Voelker and Joseph brought forth the use of indigocarmine as a test of renal function. They used a 4 per cent solution of indigocarmine injecting 4 cubic centimeters into the gluteal region. These observers made a careful study of the time of appearance of the dye in the urine the quality of the color and the frequency and force of the ejections at the meatus.

Methylene blue, rosaniline potassium iodid salicylic acid and phlorizin have been employed to determine the functional capacity of the kidneys both in various types of nephritis and in surgical diseases of these organs.

Of these substances indigocarmine has been most extensively used, especially in Europe. It has been used to some extent also in America.

Seven years after the original work of Voelker and Joseph, the phenolsulphonephthalein test was brought out by Rowntree and Geraghty. A careful study of this dye was made for a considerable time by these investigators at the Johns Hopkins Hospital and its laboratories.

During the last five years phenolsulphonephthalein has been used widely both in this country and abroad, the general consensus of opinion being that it is the most serviceable of all functional kidney tests.

Until about one year ago (March 1915) indigocarmine had been used very little in the clinic of the Los Angeles County Hospital while the phthalein test had been extensively employed in both the surgical and medical departments.

On May 4, 1915, in the examination of a woman with marked cystitis it was impossible to see the ureter mouths. Ten cubic centimeters of a 1 per cent solution of indigocarmine was injected into the gluteal region and catheterization was accomplished after the appearance of the dye.

In collecting the specimen for microscopic examination, a test tube into which a small amount of sodium hydrate solution had been put, was accidentally used, and as the blue colored urine dropped into the sodium solution it was noticed that the blue immediately disappeared and a light yellow resulted. It was the intention to estimate the relative function of the two kidneys by means of the phthalein test, and as it was noticed that the blue disappeared in the presence of the sodium solution it

seemed possible that the phthalein might be estimated in the presence of the indigocarmine. Accordingly 6 milligrams of phthalein was given intravenously and two fifteen minute specimens were collected in the usual manner. Upon diluting with distilled water and adding sodium hydrate solution until the blue disappeared, a solution was obtained very nearly the true bright red of phthalein characteristic in alkaline solution. The quantitative reading was done upon the Hellge colorimeter in the usual way.

Following this accidental occurrence the following problems presented themselves:

1. Will the color of indigocarmine in all cases be eliminated by sodium hydrate and a true phthalein color be obtained?

2. Will the same amount of phthalein be excreted by the kidneys in the presence of indigocarmine as when phthalein is used alone?

3. Will the color of indigocarmine interfere with the microscopic examination of the specimen of urine collected during the first part of the examination?

4. Will the growth of bacteria be retarded by the presence of this dye in the specimen?

An effort has been made to establish a suitable dosage for intravenous administration.

The time of appearance of the dye following intravenous administration has been observed.

A curve of excretion of indigocarmine following intravenous injection has been studied in normal persons.

A few essential physical and chemical properties of the dye have been observed and a series of thirty three patients studied. Twenty three of the patients presented pathologic conditions of the kidneys and ten normal kidneys. In the series of pathologic kidneys the earliest time of appearance of the dye was used, that is the time it appeared from the healthy side. The following method was pursued in this series:

1. The cystoscope was introduced and the bladder inspected. The ureters were catheterized and a sample collected for microscopic examination. A culture was made from each kidney on agar tubes.

2. Four cubic centimeters of indigocarmine solution containing 1 grain of the dye was injected into one of the veins at the bend of the

TABLE I.

Case	Sex	Condition	Intravenous Indigo-carmin 1 cc.	Intravenous Phenolsulpho-phthalalein 0.5 cc.	Appearance of Indigo-carmin Minutes	Appearance of Phthalein Minutes	Amount of Indigo-carmin in Half Hour Per cent	Amount of Phthalein without Indigo-carmin in Half Hour Per cent
T A	M	T B kidney	+	+		8	30	30
R L	F	T B kidney	+	+	20	4	37	41
H O	M	Renal stone	+	+	6	5	30	53
F S	F	Pyelonephritis	—	+		6	16	5
D E k		T B kidney	+	+				45
C H	F	Renal stone	+	+			25	30
G R	M	Hypertrophied	+	+		4	60	65
M A	M	Tumour of bladder	+	+		5	35	35
F T	M	Pyelitis	+	+		5	23	40
E N	F	Floating kidney	+	+			5	30
J M	M	T B kidney	+	+		35	35	37
G D	M	Tumour of kidney	+	+		5	5	
D B	F	Pyelitis	+	+	5		58	62
I K		Pyelitis	+	+	3		5	30
A B	F	Pyelitis	+	+			28	5
T O G		Hypertrophied	+	+	5		60	55
B P	F	T B kidney	+	+			5	45
S F W	M	Pyelitis and enlarged prostate	+	+		55		30
C R	M	T B kidney	+	+	6	6		5
J F W		Renal stone	+	+			65	65
I		Renal stone	+	+		0	40	45
I H L		Pyelitis and bladder stone	+	+			35	40
M M	F	T B kidney	+	+	9	8	46	50

Earliest appearance of indigo-carmin in 25 cases

Latest appearance of indigo-carmin in 25 cases

Average time of appearance

Earliest appearance of phenolsulphophthalalein in 25 cases

Latest appearance of phenolsulphophthalalein in 25 cases

Average time of appearance

Average output of phthalein in presence of indigo-carmin

Average output of phthalein when used alone

1/2 minimum amount  
2 maximum  
3/4 minimum  
5 maximum  
10 maximum  
15 maximum  
25 65 per cent  
44 87 per cent

elbow. The time of the appearance of the dye at the end of the catheters was noted on each side. A specimen for comparative microscopic study and a culture for comparison with the ordinary culture were taken.

3. One cubic centimeter of phenolsulphophthalein was not injected into one of the arm veins and the time of its appearance noted. A half hour specimen was taken from each side and the bladder catheterized to measure the leakage.

4. Each specimen was diluted to 250 or 500 or 1000 cubic centimeters with distilled water, and sodium hydrate solution 15 per cent added until all trace of blue disappeared from the

solution. The amount of phthalein was estimated in the colorimeter and recorded.

5. The specimens collected from the catheters, both plain and in the presence of indigo-carmin were centrifugalized and examined.

6. After twenty four to forty-eight hours the two cultures were compared.

7. A few days later the patient was given an intravenous injection of 1 cubic centimeter of phthalein, after the bladder had been emptied by urination or catheterization, and after about 500 cubic centimeters of water had been drunk. At the end of thirty five minutes the excretion was collected, read in the colorimeter and

TABLE II.\* INDIGOCARMIN INTRAVENOUS 4 CCM.

Case	Sex	Condition	First 5 Minutes Per cent	Second 5 Minutes Per cent	Third 5 Minutes Per cent	Fourth 5 Minutes Per cent	Total Hour Per cent
P. L.	M	Normal	14	4½	3	½	24
L. V.	M	Normal		4	4	3	3
C. V.	M	Normal	8	3			5
J. W. G.		Normal	1	1	2½	½	26
J. C.	M	Normal	9	6	3		20
M. S.		Normal		½			26½
J. C.	M	Normal	23	½			28½
S. C. S.	M	Normal	8		3		34
W. H.		Normal	17	8			8
H. K.		Normal					

Average output first fifteen minutes: 7.1 per cent.

Average output second and third fifteen minutes: 7.7 per cent.

Output for one hour: 26.6 per cent.

recorded in a column opposite that estimated on the prior examination.

Upon comparing the two last columns in Table I it is seen that the output of phthalein when read in the presence of indigocarmine nearly equals the output when used alone.

The variations lie in the majority of reading within 5 per cent, a fact that can be accounted for as being due to error in the colorimetric estimation.

The average output in twenty three cases in both instances falls within 1 per cent of each other.

After a comparative examination of the slides and cultures it was soon definitely found that the presence of indigocarmine did not interfere with such study of the urine. Therefore this part of the work was not carried out for all of the patients examined being done only when indicated for diagnostic purposes.

In order to administer the phenolsulphonephthalein at a time when the smaller amount of indigocarmine was excreted, an effort was made to determine the period following the intravenous injection of indigocarmine during which the greater quantity of the dye was excreted, and with this in mind normal patients were examined in the following manner.

The patient was instructed to empty the bladder and drink a pint of water.

One grain of indigocarmine was given intravenously. Five minutes were allowed for the time of appearance and collections of the urine made every fifteen minutes for one hour.

A standard solution of indigocarmine was prepared by mixing 4 cubic centimeters of the stock solution or 1 grain with 1000 cubic centimeters

of distilled water. This solution was placed into the wedge-shaped cup of the Hellge colorimeter and the quantity of dye excreted estimated in the same manner as for the phthalein (see Table II). A few patients were observed at the end of the second and third hour. The color became too pale for estimation on the colorimeter at the end of the second hour and barely a trace could be seen at the end of the third hour.

A study of these cases indicates that only about 25 per cent of the indigocarmine is excreted by the kidneys and that about 15 per cent is excreted during the first fifteen minutes following its appearance in the urine. During the next half hour about 8 to 10 per cent is excreted by both kidneys making from 4 to 5 per cent for each side in normal persons.

Transferring these last figures into terms of grains it will read that only ¼ grain is excreted by way of the kidneys and this takes place during the first hour.

During the second and third fifteen minute periods about 1/80 grain is excreted by each kidney in normal persons. It is during this period in order not to prolong the examination that the phthalein can best be collected.

If the collections are made in two fifteen minute periods approximately only 1/160 grain should be found in each reading. This amount of indigocarmine requires but a small amount of sodium hydrate solution for its disappearance only slightly more than that required for the phthalein test alone (about 1 cubic centimeter—15 per cent solution) but enough should be added to destroy any trace of blue.

Should the resulting color not show the characteristic bright red of the phenolsulphonephthalein

a small amount of the diluted solution should be filtered, a pus, blood and other debris in the urine may be responsible for the disturbance in the color. If the resulting solution is not the proper texture of color a filtered specimen should be placed in a small test tube and boiled a few seconds. Boiling in the presence of sodium hydrate will completely oxidize the indigocarmine. The phthalein is not affected by boiling in alkaline solution.

In a given case when there is difficulty in locating the ureter mouths the following procedure is recommended:

1. Four cubic centimeters of indigocarmine solution is injected into one of the arm veins after the cystoscope has been used for inspection of the bladder. The region of the inguine is kept under observation for the appearance of the blue color. The time of appearance on each side is recorded. The catheters are then passed into the ureters and specimens collected for microscopic study. Cultures are made if indicated. These procedures will occupy fifteen to twenty minutes.

Six milligram of phenolsulphonephthalein is injected intravenously and the time of appearance on each side recorded. Either a half hour or two fifteen minute specimens are taken and the bladder emptied to collect any leakage. The quantity of phthalein is estimated as described above.

In the literature perused in this study there is no complete description of indigocarmine and only a few observations regarding the physical and chemical properties.

**Physical and chemical properties.** Indigocarmine is the sodium or potassium salt of indigulphthaleic acid ( $H_2 C_{16} H_8 N_2 O_7 (SO_3^-)$ ). It is soluble in water 0.8 per cent is of a dark blue color. Its reaction to litmus is neutral and it can be sterilized by boiling or by steam pressure.

By the addition of sodium hydrate solution a yellow color results and on the addition of sodium hydrate solution and boiling a clear solution is obtained.

If sodium hydrate is added to a solution of indigocarmine until all trace of blue disappears a pale yellow color is the result while on the addition of acetic acid it again becomes the characteristic blue of indigocarmine. By rendering a solution of indigocarmine distinctly alkaline and then boiling the solution, a complete oxidation occurs and the acetic acid does not restore its color.

This behavior of indigocarmine toward sodium hydrate makes it possible to bring out the char-

acteristic red of phthalein by adding sodium hydrate which at the same time changes the indigo into a yellowish tint. By boiling a small sample of the resulting dilution the indigocarmine is completely oxidized, while the phthalein is not affected by boiling in an alkaline solution.

**Stability of indigocarmine.** In order to determine the stability of indigocarmine, a solution was prepared containing 1 grain to 1000 cubic centimeters of distilled water. Three bottles were filled with this solution:

1. A dark glass bottle
2. A clear glass bottle containing a small amount of acetic acid
3. A clear glass bottle

These bottles were set away on a shelf of an instrument cabinet in the cystoscopic room and examined after 58 days in the following manner:

A fresh solution of 1 grain in 1000 cubic centimeters of distilled water was made up, the wedge-shaped cuj in the colorimeter filled with this solution and each sample compared against it.

A similar observation was carried out by adding nitric acid, sulphuric acid and hydrochloric acid to three bottles containing indigocarmine solution, 1 grain to 1000 cubic centimeters and examined at the end of seventy days.

From these observations it will be seen that indigocarmine is stable in ordinary watery solution and in the presence of acetic acid.

The dye is rapidly oxidized by nitric acid, slightly oxidized by sulphuric acid and less affected by hydrochloric acid.

By slowly adding sodium hydrate to a solution of indigocarmine the color first changes to a greenish tinge and finally to a light yellow. In alkaline urine this variation in color can be observed, i.e. a greenish appearance of the excretion which can be restored to its characteristic blue color by addition of acetic acid. When resorting to colorimetric estimation of this dye, a few cubic centimeters of acetic acid should be added to the dilutions to obtain a neutral or acid reaction of the solution.

Indigocarmine is soluble in water in 0.8 per cent. It has been noted that when a stronger suspension of the dye is injected intravenously, transitory symptoms of shock varying from mild manifestations such as dizziness and pallor to almost complete collapse will occasionally occur. These manifestations are possibly due to the action of undissolved particles of the dye as momentary thrombi. For this reason the dye should be used intravenously only when in complete solution and carefully sterilized.

A 5 cubic centimeter ampule of the saturated

solution contains approximately three fourths of a grain of indigocarmin and forms a serviceable and safe method for the test

### CONCLUSIONS

1 When indigocarmin and phenolsulphonephthalein are excreted simultaneously the addition of sodium hydrate eliminates the color of the indigocarmin and brings out that of the phthalein.

2 Phenolsulphonephthalein is excreted by the kidneys in the same amount whether used alone or simultaneously with indigocarmin

3 The presence of indigocarmin does not interfere with the microscopic study of the specimen of urine.

4 The growth of bacteria is not retarded by the presence of this dye in the culture.

5 Five cubic centimeters of a saturated solution of indigocarmin forms a suitable and safe dose for intravenous administration.

6 A quantitative colorimetric estimation of indigocarmin can be carried out

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## A RARE DEVELOPMENTAL ANOMALY OF THE RECTUM WITH A DESCRIPTION OF THE OPERATIVE TECHNIQUE EMPLOYED FOR ITS CORRECTION

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### EMBRYOLOGY

THE rectum develops from that portion of the hind gut (Fig. 1 G) which grows toward the tail end of the embryo. It is known as the postallantoic gut (Fig. 1 P A G). As the embryo grows the postallantoic gut buds still more backward and the allantois becomes a ventral diverticulum (A Fig. 2). The communication existing between these two structures is finally obliterated and the allantois becomes part of the urinary tract. The final steps in the completion of the development of the rectum consist of the meeting of postallantoic gut with the proctodæum (Fig. 3). The latter grows upward from the anal depression in the skin toward

the gut and pushes the mesoblast aside until a membrane consisting of epiblastic and mesoblastic epithelium alone separates the two lumina. This membrane has been termed by Minot (1) the anal plate. (Fig. 3 A P). In the human embryo this plate becomes perforated according to Ball (2) at the end of the fifth week, and the vestigial remnants are represented in the adult as the anal valves. In the lower animals Minot (1) has observed that the anal plate does not become perforated at once but that it is first converted into a cord of cells and as the tail curves more anteriorly this "cord" shortens and a membrane composed of two layers of epithelium again appears. Then



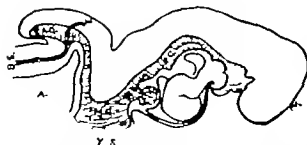


Fig. 2

Fig. 2. Diagram of the testicular canal of a very young human embryo (from Ball). F.G. foregut H.G. hindgut P.A.G. postallantoic gut M.G. midgut B.S. body stalk A. allantoid Y.S. yolk sac W. wolffian duct

Fig. 3. Vertical section of embryo (Wood Jones). The postallantoic gut (P.A.G.) is budding backward



Fig. 2.

the growing hind end, and the allantoid (A) has become a ventral diverticulum.

Fig. 3. Vertical section of still older embryo (Wood Jones). The postallantoic gut (P.A.G.) has met the proctodaeum and has lost its connection with the allantoid. P. anal plate

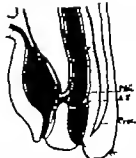


Fig. 3

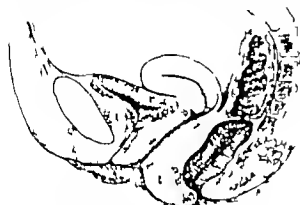


Fig. 4. Drawing showing fibrous band dividing the dilated pouch into two irregular chambers A and B

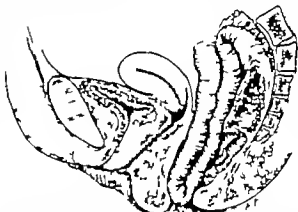


Fig. 5. Drawing showing the detached portions of the sigmoid and upper rectum which has been brought down to the anal margin. Author case



Fig. 6. Double-barreled lumen produced in the case

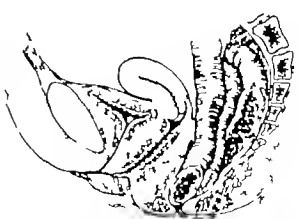


Fig. 7. Morphological condition of the rectum in the author case

only does it perforate and a permanent opening is established. With the aid of this brief embryological review the anomaly in the case which is herewith reported will probably be better understood.

Della K. age fourteen began to menstruate at 12 years and 6 months every five to six weeks profuse in amount, lasting from six to seven days. Occasionally she suffers from dysmenorrhea after the onset of the flow. Her last period occurred four weeks ago.

*Previous diseases* with the exception of chorea three years ago has never been ill.

*Present illness* For the past five years, she has been suffering from obstipation which is gradually growing worse. At present her bowels move once in four or five days and that by means of an enema only. In addition to the marked constipation, she is also troubled with backache, lassitude, and irritability. One month ago she was suddenly taken ill with an attack of abdominal cramps localized to the left lower quadrant, followed by rectal hemorrhages which lasted for two weeks.

*Physical examination.* Her height and weight are slightly above normal, heart, lungs, abdomen, and external genitalia normal. At a point, about three and a half inches from the anus corresponding in location, to the lowest of Houston's valves a constriction is encountered, with a lumen not larger than the diameter of the little finger surrounded by a distinct tough membranous rim. From this area downward to the internal sphincter and the rectal ampulla consists of an extremely dilated pouch, with thin walls devoid of the usual corrugations in the mucosa, which form the columns and the sinuses of Morgagni. Traversing this pouch in a longitudinal direction and in a zigzag fashion is a fibrous band, which divides it into two irregular chambers (Fig. 4).

*Operation.* On March 9 1935 I performed the following operation. With the patient in the Trendelenburg position, the peritoneal cavity was entered through a left rectus incision. On palpating the rectum, the constriction which was felt from within, could now also be perceived by the examining fingers. About five inches of the sigmoid and the rectum up to its peritoneal reflection were freed from their mesenteric attachments. A pedicle clamp was introduced into the rectum, making it impinge against the anterior wall, at a point a little below the site of the constriction. An incision through the posterior cul-de-sac, over the point of the clamp was made and a communication established with the lower portion of the rectum. The clamp was now pushed into the peritoneal cavity the piece of tape which was previously fastened to the freed loop of intestine was grasped and pulled down, bringing with it, the detached portions of the sigmoid and upper rectum, to the anal margin (Fig. 5). The peritoneal edges of Douglas's cul-de-sac were now sewed to the edges of this loop, thus rendering it extra-peritoneal. The abdominal cavity was closed in the usual manner and the patient placed in the lithotomy position. The sphincter was dilated, and the intestinal loop fastened with a few interrupted sutures to the anal mucosa. The anterior or lower wall of the loop was incised thus producing a double barreled lumen (Fig. 6). Rubber

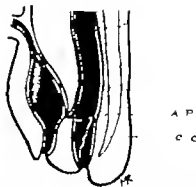


Fig. 8 A diagrammatic representation of the most probable embryological defects that have caused the anomalies in the case reported. A P anal plate but partly absorbed C C cord (cells which correspond to the band in the rectum).

tubing was introduced into the proximal and the distal ends, secured temporarily in place, dressings applied, and the patient returned to bed.

The postoperative course was most satisfactory. On the seventh day the patient was again placed in the lithotomy position under gas oxygen anesthesia, with the idea in mind to crush the existing spur and make the aboral end of the newly constructed rectum much wider. However an examination disclosed that the intestinal partition had retracted of its own accord, making the contemplated operation unnecessary. The morphological condition of the rectum at present is well illustrated in Figure 7. The distal portion of the loop is represented by a narrowed diverticulum, the proximal portion is wide, and forms the terminal segment of the rectum continuous above with the sigmoid. The finger or proctoscope enters without encountering any obstructions the spur can still be felt high up and to one side. Since her complete recovery from the operation, the patient has been free from constipation, requiring no laxatives, cathartics, or enemata. She is pursuing her studies with diligence, and is enjoying good health.

#### EPICRISIS

The constriction in the rectum corresponds to the site of the anal plate which has not become completely absorbed (Fig. 8). The fibrous band that was present in the rectal pouch, below the point of constriction is probably the cord of cells (Fig. 8 c c) described by Minot as occurring in the lower animals and it may therefore be considered as a reversion to a remote ancestral embryology.

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# TRANSACTIONS OF SOCIETIES

## CHICAGO SURGICAL SOCIETY

REGULAR MEETING HELD JANUARY 5 1917 WITH THE PRESIDENT DR WILLIAM M. HARRIS  
IN THE CHAIR

### COMPLETE COLECTOMY FOR VULVUS OR THROMBOSIS

DR NORMAN KERR Many surprises have been met with by almost all surgeons and the writer believes he has encountered the most startling in the literature at the following history will probably prove

The patient, a woman, age 47, weight 112 pounds, has had two children, now 19 and 23 years old, was operated upon for uterine fibroid two years ago by Dr H. O. Shafer at which time he also removed the appendix. Nothing abnormal was noted about the colon. She made the usual uninterrupted recovery and suffered no inconvenience except from constipation, which seemed to increase after this operation, and she had two or three attacks of colic from which she recovered with the use of enemas.

On August 24, 1916 she was seized with severe pain in the left lower quadrant of abdomen and her attending physician, W. J. Schaefer, succumbed to various enemata, in bringing away a fecal mass six inches long by nearly two in diameter. The bowels were obstinately constipated the next day and on the second day, August 26, she was again seized with pain in the left lower quadrant of abdomen about 11 a. m. and Dr Schaefer saw her about 1 p. m. at which time he detected a mass in the region of the sigmoid and advised immediate operation. During all this time, the patient's abdomen remained flat and the pain was becoming continuous. She was admitted to the Henrotin Memorial Hospital where she was examined at 6:30 p. m. by Dr Schaefer just before the operation, when her abdomen was distended to the size of a full-term pregnancy and the patient still complained of severe pain. A median incision of eight or ten inches revealed a dark, cyst-like mass which extended up on both sides of the abdomen and crossed it above the line of the upper end of the incision. This was removed from within the abdomen and found to be the whole of the colon and sigmoid flexure with

a twist in the pedicle (if I may so term it) just above the sacrum.

The position of the cecum was to the right side, the whole of the mesocolon, ascending, transverse, and descending, was separated from the colon so that when the pedicle was untwisted, it required one complete turn from left to right.

A clamp was applied to the ileum pedicle and colon, the gangrenous colon cut away and a lateral anastomosis performed between the ileum and colon just above the sacrum. The open end of the colon, three or four inches above the sacrum, was slightly discolored and it was thought advisable to invaginate about an inch before applying the circular suture. The end of the ileum was invaginated in the usual way, several large cigarette drains were placed along the line of the attachment of the ascending and descending mesocolon to the posterior abdominal wall, the fascion sutured, and the patient was returned to bed in good condition.

For several days a large amount of serum drained away, otherwise nothing untoward occurred until she became troubled with diarrhea, because she had no colon to absorb the liquid portion of the contents of the small bowel. This gradually improved with regulation of the diet, until she would go twenty-four hours without a bowel movement.

Dr Alova Heinen made an examination of her stool on October 16, 1916 and reported as follows: Gross appearance — well formed, of a dark brown color, slightly sticky, a fairly good odor. Macroscopically on maceration very little connective tissue, some fat. Microscopically some well digested muscle fibers, a very few undigested single muscle fibers, two parts containing 10 or 15 muscle fibers enveloped in connective tissue. Starch, non-digested starch granules. Fat, some neutral fat globules undigested. Some detritus, cellulose plant cells or fibers. Nothing pathological otherwise except above mentioned undigested muscle fibers and fat.

In a personal conversation with Dr. Heinen he

informed me that some German investigator showed that the colon played an important part in digestion for instance the discharge of a fistula from the cæcum would show many undigested muscle fibers whereas that from the descending colon or sigmoid would show very few if any — an important point for consideration it would seem to any one contemplating the operation of short circuiting or complete colectomy.

The history would seem to show that the volvulus commenced in the sigmoid portion of the colon traveled upward to the splenic flexure across to the hepatic then down to the cæcum separating in its course the mesocolon from the different parts of the colon in its progress upwards because the primary symptoms were referred to the sigmoid and the separation must have taken place from below upward and one complete revolution from left to right was the only possible way in which such a twist in the attachments of the mesentery of the ileum and mesosigmoid could have occurred. It was noted that there were four bleeding points when the clamp was loosened one near the ileum presumably the terminal loop of the mesenteric artery two larger ones near the middle of the pedicle, and the fourth near the pelvic colon. There was no venous oozing to control and as haste was considered important, the writer did not attempt to investigate the neighborhood of the transverse mesocolon although it was noted the distended colon showed areas of denudation of the peritoneum in its whole length.

A new problem in etiology was presented by this case which the writer tried to have cleared up by his surgeon friends in Chicago but to no avail.

I confess I cannot explain why this remarkable condition should occur viz. such an extreme distention of the colon as to cause tearing of the mesocolon, which seems hardly possible, as the cæcum the most distended part, was not more than six inches in diameter or again who has ever heard of a volvulus causing such tearing of peritoneal supports in any part of the abdomen.

One point in the history may help to clear up this question viz. she had had two or three attacks in which bleeding from the lower bowel took place within the last year. The specimen has not as yet been examined for any growth from the mucosa.

Dr Adolph Hartung very kindly took some roentgenograms of the rectum and abdomen which are remarkable in that they show a fairly good imitation of a transverse and descending colon also a fair imitation of a cæcum and

after he was told what the operation was he could not explain the shadows as shown. The patient afterward came to his office was given a bismuth meal and rayed, at three different periods and the roentgenograms show that the small intestine must have adhered to the denuded surface of the mesocolon and given the above-mentioned startling imitation.

DR ALOYS HEINEN. On examining the stool of Dr Kerr's patient I found connective tissue which proves that the stomach function was below normal. This was verified later by making an analysis of the stomach contents in which I found achylia gastrica also some undigested muscle-fibers and a few undigested starch granules. Some fat globules were also found in the stool.

As such operations are performed to cure colonic stasis we should not lose sight of the physiologic function of the colon and the enormous amount of absorption which takes place in that organ. If we consider the amount of fluid in the contents of the bowel as it passes from the ileum into the colon and after passing through the colon the solid state when finally expelled we will realize the amount of absorption that takes place in the colon.

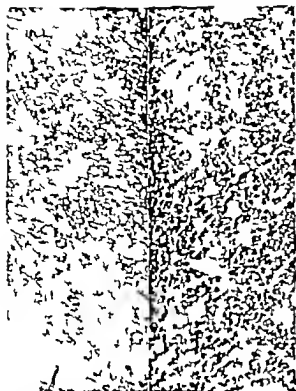
As to the muscle fibers it has been proved by forming a cecal fistula that digestion takes place in the colon for examination of the discharge from the fistula reveals undigested muscle-fiber while that of the stool later shows digested fiber which can be understood when we know that the stool contains trypsin.

Before resorting to such severe operations for constipation we should ascertain whether the constipation is due to any organic disturbance such as obstruction adhesion, etc. This can be determined by examination with the recto-sigmoidoscope, roentgen ray etc. My experience in these cases has been that constipation is due in most cases to a functional disorder although there are always some organic changes caused by improper living for example improperly cooked food or improper eating hours etc.

We ought to begin with the stomach examination in making our diagnosis as many of the cases are of a gastrogenic origin and, I am sure we can cure nearly all of the cases by bringing the patient back into a proper mode of living.

#### DISCUSSION

DR DANIEL N. EISENDRATH. It does not seem to me as though Dr Kerr's case is so rare. I have had two cases duplicates of these. Both of them proved to be volvulus of a megacolon



Hepatic hypernephroma. Dr. Carl G. Swenson's case. Slide on right magnified 300 times.

or Hirschsprung's disease. His specimen is quite typical of that condition. The immense size of the gut, the enormous thickening of the walls show that this is not a condition which has existed for a few months but is a congenital condition.

#### HYPERNEPHROMA OF THE LIVER

**Dr. Carl G. Swenson.** My object in presenting this specimen is to obtain the opinion of the fellows of the Chicago Surgical Society as to the diagnosis. The patient's weight eighteen days after the operation was 120 pounds but it has now increased to 155 pounds. She is at present in perfect health.

The patient, a woman of 58, was admitted to the Passavant Hospital April 4, 1916.

**Previous history.** The patient has always enjoyed good health. She was married at nineteen and has given birth to eleven children.

**History of the disease.** The patient has been ill for one year. The first symptoms noticed were constipation and abdominal enlargement in the epigastric and umbilical regions. In September 1915 the patient discovered by manipulation, a lump in the epigastric region.

For two months, February and March, 1916 the patient was unable to lie down in bed, but was obliged to sit continually in a chair.

**Examination.** By palpation, a large oval-shaped smooth, hard, and movable tumor was found in the epigastric and umbilical regions. It measured in its three diameters 25x25x20 cm.

**Diagnosis.** Probably a malignant growth. It was difficult to determine the origin of the tumor. It might have arisen from the mesentery, omentum, transverse colon or liver or it might possibly have been a fecal mass.

**Blood examination.** Erythrocytes 5,500,000; leukocytes 9,600; and hemoglobin 75 per cent. Urine normal.

**Preparatory treatment.** (After the patient's entrance into the Passavant Hospital.) On alternate days during three weeks she was given two to three ounces of castor oil and one ounce magnesium sulphate and in addition daily enemata and colonic flushings. From this eliminating treatment the tumor was reduced to its real size, 12x12x8 cm.

**Operation April 25, 1916. Anesthesia.** Ether five ounces. Morph. sulph. gr.  $\frac{1}{2}$  hypod. The anesthesia began at 9:30 a.m. and discontinued at 10:00 a.m. An incision 12 cm. in length was made through the right rectus muscle. On opening the abdominal cavity a very vascular, smooth, and dense tumor was found adherent to the inferior surface of the liver. The gall bladder was free and normal. To the left costal arch, the tumor was attached with an omental band.

By blunt enucleation the tumor was separated from the liver to two cm. within its lower edge, where further enucleation became impossible. Therefore in order to liberate the tumor the edge of the right hepatic lobe was excised two by ten cm. and the tumor removed. There was no excessive bleeding after excision of the liver edge. The diameter of the tumor measured 12.5 cm. and it weighed two kilograms. A large plain gauze drainage pad was placed under the liver and the wound sutured.

**Postoperative report.** April 26 temperature 97°F to 98°F. Pulse 116 to 104. April 27 temperature 100°F to 103°F and 105°F. Pulse 124 to 145 and intermittent. The removal of drainage gauze caused the rising temperature and intermittent frequent pulse.

April 28 temperature 98.6°F to 100.8°F. Pulse 106 to 112. On the tenth day after operation the temperature became normal and on the sixteenth day the patient sat up on a chair. On the eighteenth day she weighed 120 pounds. Five weeks later her weight had increased to

134 pounds a gain of fourteen pounds. Her weight on entering the hospital was 140 pounds and previous to her sickness her average weight was 180 pounds. On September 26 the patient weighed 144 pounds an increase of ten pounds since June.

The patient left the hospital June 20 eight weeks after operation, with an abdominal fistula. This fistula closed September 18 twenty-one weeks after the operation.

Ever since the patient returned home from the hospital she has done her usual daily housework and continues to enjoy good health. January 1 1917 the patient weighed 155 pounds an increase of 35 pounds.

**Pathological report** Numerous sections were taken from the tumor and mounted on slides for microscopical examinations. The slides have been examined by four eminent pathologists of highest authority. The conclusive diagnosis reached by them differs. Positive diagnosis by Professor Ludwig Hektoen and E. R. Le Count, states the tumor to be a hepatic hypernephroma. by Professor Maximilian Herzog an endothelioma by Dr William C. McCarty Rochester Minnesota primary carcinoma of liver. For various reasons drawn from the clinical result the indications strongly favor the diagnosis hepatic hypernephroma, given by Professor Hektoen and Le Count, as the most correct one.

**Present condition August 13 1917 Weight 131 pounds** By manual examination the recurrence of the tumor was found in March 1917. Present size of tumor located in right hypochondriac region, is about 15x10 cm. Patient eats and sleeps good and she feels well and comfortable.

#### DISCUSSION

DR. LECOUNT I wish to mention the following characteristics of hypernephroma

1 The great disposition of these tumors to invade the renal vein and also to be carried by lymph-channels producing secondary growths in the lymph glands not only in the abdomen but in the thorax as well.

2 As to the controversy that has been had over the origin from renal tissues the present evidence seems inadequate. Hypernephromata occur as primary tumors of the liver and of the adrenals as well. The tumors generally grow in structures developed from the wolffian body.

3 The characteristics of the histological structures the occurrence of huge cells full of holes in the usual preparations and of fat molecules in preparations stained to demonstrate it

the arrangement of these cells in rows the lack of atroma and the frequency of necrosis.

4. The orange yellow color of the surfaces made by sectioning the fresh tumor growth.

5 The frequent occurrence of metastases in bone.

DR. A. J. OCHSNER It is perfectly clear from these pictures that Dr Swenson's case is a hypernephroma and nothing else but the diagnosis can be confirmed later on by the autopsy. Every one who has seen many hypernephromata knows that very commonly a tumor is found elsewhere first and later on a tumor is found in the suprarenal gland which may be very small and that the metastatic tumor is simply a portion which has accidentally been separated and has become lodged somewhere else and started the tumor which one mistakes at first for a primary growth. The whole structure is so typical that it cannot be anything else.

#### OPEN SURGICAL TREATMENT OF BONE AND JOINT LESIONS

DR. CARL BECK read a paper entitled Open Surgical Treatment of Bone and Joint Lesions.

#### CYSTICODUODENAL AND CYSTICOCOLIC LIGAMENT

DR. WELLER VAN HOOK read a paper entitled The Surgical Significance of the Cysticoduodenal to the Cysticocolic Ligament. (See p 551)

#### DISCUSSION

DR. M. L. HARRIS It will be remembered that two years ago I presented before this society a paper on the structures which the doctor has spoken of tonight. At that time I endeavored to show that these structures are due to the persistence of the caudal edge of the anterior mesogastrium. The anterior mesogastrium during embryologic life extends from the abdominal wall in front back to the gastro-intestinal tract and later its remains occupies a position to the right of the duodenum by reason of the turning of the duodenum to the right. When this caudal edge persists it may persist as a distinct fold extending from the anterior abdominal wall to the intestines or it may persist simply as a fold or band from the liver to the intestine or from the gall-bladder to the intestine, and the hepatoduodenal ligament is but a remnant of the caudal edge of this anterior mesogastrium. The reason this fold occasionally extends from the gall bladder to the colon as the so-called cysticocolic liga-

ment is due to the fact that when the colon turns over from the left to the right it comes in contact with the caudal edge and takes attachment to it and carries the fold along with it.

Since I called attention to the persistence of this anterior mesogastrium it has been confirmed by others and shortly after I presented that paper an interne brought me a beautiful specimen which he had just found at the Cook County Hospital while making an autopsy on a stillborn child. Having read my paper he recognized this anterior mesogastrium and brought the specimen to me. It was a beautiful specimen of the persistence of the anterior mesogastrium from the duodenum along the surface of the liver to the anterior abdominal wall showing that in this stillborn child the anterior mesogastrium had not disappeared and probably would have persisted into adult life as a distinct fold had the child lived. In my paper I called attention to the persistence of the anterior mesogastrium in various degrees, its effect on the duodenum and its effect upon the gall bladder.

DR. DAVID C. STRAIN: I wish to speak of a case of familiar nature that I saw about three weeks ago. The case was brought to me with the diagnosis of acute appendicitis. Before I examined the patient I obtained an appendix history and a gall bladder history that was just as definite. On examination the appendix was palpable and very tender but in addition the patient was very tender under the right costal arch and gave a history of having more or less constant pain in this region and in addition typical gall bladder colics which came on with pain in the gall-bladder area, radiating anteriorly toward the median line and then deeply upward into the chest, and pain radiating to the right shoulder. From her story it was clear that most of her trouble was from her gall bladder. To be absolutely certain that there was no duodenal or gastric ulcer in addition to the usual test meals I made a thorough roentgenological examination of her gastrointestinal tract and was surprised to find she had marked gastropnoia. While I was examining her before the fluoroscope without asking her anything about her pain I made firm pressure against her hypogastrium pressing with both of my hands thus supporting her stomach so that the greater and lesser curvatures were held up in a normal position. She at once volunteered that she felt much better. When I released the pressure her pain returned again.

At operation I made a regular gall-bladder incision through the right rectus muscle, and on examining the gall-bladder found that it was

quite large, thin walled and that there were two broad bands which I believed were adhesions uniting the gall-bladder to the duodenum and to the transverse colon. These were on the free surface of the gall-bladder and extended from the cystic duct almost to the fundus. They were similar in distribution to those which Dr. Van Hook has described and illustrated and they were as definite and as extensive as those he showed in his last lantern-slide which were marked. In my case however they were heavier than in any of the pictures shown tonight. Because of the enlargement of the gall-bladder and the history I believed these bands were adhesions, and I felt convinced that the more or less constant pain in the gall-bladder region which she had had for 5 years, had been due to the fact that the ptosed stomach dragged the colon downward and thus in turn through the band uniting the colon with the gall bladder made traction on the gall bladder and this caused the pain of which the patient complained particularly when she was up and about.

I did a cholecystectomy and then after I had finished the operation I reached down from the gall bladder incision to feel the appendix. I could distinctly feel that the appendix was enlarged contained two enteroliths, and that its walls were greatly thickened. There were no adhesions about the appendix, but it was kinked on itself. It was indicated to remove the appendix inasmuch as the history and clinical findings pointed to a diseased appendix. I made a small muscle splitting incision and took out the appendix from below.

The gall-bladder after removal was opened and showed the typical picture of a strawberry gall bladder. The histological examination made by Dr. Schultz showed lymphocytic infiltration of the gall-bladder wall and in addition showed that the mucosa was denuded in areas. The appendix showed chronic hyperplastic appendicitis, and subacute catarrhal appendicitis. The patient made an uneventful recovery and left the hospital 2 weeks after the operation. There has been no more pain in the gall bladder region. I had a gastropnoia belt made for her before she left the hospital.

This particular patient's history dated back to a confinement 5 years ago and I thought the inflammatory condition probably developed during the pregnancy. It may well be, however, that that pregnancy was the cause of her gastropnoia, and that the more or less constant pain in the gall-bladder region since that time, was due to a dragging on the ligamentum hepato-

colicum at times kinking the gall bladder and causing obstruction and secondarily cholecystitis. In substantiation of this is the fact that when she lay in bed at night, she felt much better. The reason the ligament was so thick in this case was probably due to sclerosis caused by the constant pulling and dragging it sustained caused by the gastropnoxis.

In closing I wish to state that it seems probable to me that if a patient with a well marked ligamentum hepatocolicum develops gastropnoxis of high grade the traction of the stomach dragging

down the colon and this in turn pulling on the gall bladder may give rise to typical symptoms of chronic cholecystitis and in case of kinking at the neck of the gall bladder or cystic duct so that the gall bladder cannot empty itself may give rise to typical attacks of gall bladder colic.

#### THE SILENT COMMON DUCT STONE

DR DANIEL N. EISENDRATH read a paper on  
The Silent Common Duct Stone

## CHICAGO GYNÉCOLOGICAL SOCIETY

CLINICAL MEETING AT THE COOK COUNTY HOSPITAL, FEBRUARY 16 1917

THE REGULAR MONTHLY MEETING OF THE CHICAGO GYNÉCOLOGICAL SOCIETY WAS HELD IN THE  
SURGICAL AMPHITHEATRE OF THE COOK COUNTY HOSPITAL ON FEBRUARY 16 1917  
WITH PRESIDENT DR. CHANNING W. BARRETT IN THE CHAIR

#### GENERAL PELVIC PERITONITIS

DR. CAREY CULBERTSON showed four cases of general pelvic peritonitis and stated I prefer the diagnosis of general pelvic peritonitis rather than that of pus tubes. These cases were all advanced in which the tubes ovaries and pelvic peritoneum, with more or less of the cellular tissue were involved. They are shown in order to demonstrate the method of treatment employed in acute and subacute stages, in preparing them for the radical operation if they came to that later.

At the County Hospital the greater proportion of cases of pelvic peritonitis occurs in women between the ages of fifteen and twenty five a few of them only being older. As a result of their youth the tendency has been toward conservative treatment in order to preserve menstruation later if the patients come to operation.

CASE 1 demonstrates this condition very well. She is a girl twenty years of age a domestic who came into the hospital on February 3 complaining of pain in the hypogastrium and leucorrhœa. The onset had been two weeks previously. About the middle of January there was a sudden onset with acute sharp pain in the hypogastrium which confined her to bed. She had fever at that time and a slight chilly feeling but no nausea. She had had leucorrhœa for some time did not know how long. One year ago she had an induced miscarriage following which she had pain in the hypogastrium and was confined to bed for about a week. She came into puberty at 14 menstruation had been regular every 4 weeks lasting for 3 or 4 days. She had had only the one pregnancy

When she came into the hospital she had a temperature of 101.2 F 101.4 F 101.6 F 101.8 F varying from 98.8 F to 101 F for several days. I saw her first on Tuesday and at that time the temperature was 101.2 F she had been in bed for several days. There were 14,000 leucocytes.

*Examination.* The abdomen was distended and tense, with tenderness and rigidity just inside of the right anterior superior spine. The uterus was large, retroverted, soft, tender and fixed. The right side of the pelvis was occupied by a large mass which bulged down into the vaginal fornix posteriorly. The cervix was pushed forward behind the symphysis. The mass gave a semi fluctuant sensation on palpation not as clearly fluctuant as the retroperitoneal abscess in postpartum sepsis.

Considering that she had this mass I requested Dr. Barrett to drain her pelvis the next morning which was done, thus evacuating a large amount of pus on the 14th. On the 15th the temperature was 101.6 F and since then it has not been above 99.4 F. This patient will be allowed to drain for sometime if the fever stays down it is an indication that the pus is draining out. After the patient has been afebrile for some time she will be kept in bed absolutely quiet until the draining ceases and by that time we can decide whether any other operative procedure is necessary.

CASE 2 is that of a colored girl, nineteen years of age who came into the hospital on February 12 complaining of pain in the hypogastrium leucorrhœa, dysmenorrhœa, and constipation. One year ago she had a little leucorrhœal discharge which persisted until the present time but never necessitat



ed wearing a napkin. The patient now menstruates five days instead of three as she did prior to this onset. Four days ago she had pain in the hypochondrium colicky in nature becoming more severe until she entered the hospital. Dysuria began about this time associated with pain. Constipation has been present for a long time the patient using cathartics constantly. She has had the diseases of childhood only an 11 three day periods regularly every month. She has missed 6 periods. Blood examination shows 15,000 leucocytes.

Examination on Monday showed a rather tense abdomen on palpation, no localized pain. The vagina was negative the cervix was forward and up slightly oedematous and free. The uterus was retroverted a tender mass on either side filling the pelvis but not bulging down as in the case before and not giving evidence of fluctuation.

The temperature has not been very high. This represents an acute exacerbation of an old chronic process. The temperature has run along 99° F. 99.4° F. practically afebrile but owing to the tenderness and slight rigidity of the abdomen and the pain, I consider this subacute process and not to be invaded abdominally at the present time. The patient will be kept in bed until the temperature entirely subsides and then discussion will be made as to further treatment.

This case does not require drainage in its present state. When these cases clear up and become afebrile and the abdomen becomes soft we do not find drainage of the pelvis necessary. Where patients have been in bed and the temperature continues especially if accompanied by chills we are practically certain that the patient is developing an abscess and examination will then reveal a soft mass which upon incision turns out pus. This case is not going through that process. The difficulty in many of these cases is to keep them in the hospital. As soon as they become afebrile they wish to go home and often are permitted to but they only have another exacerbation and soon return.

Case 3 is a 21 year old girl who has just been said. This girl is twenty-one. She came in on January 21 giving the history of pain in the right side at McBurney's point and leucorrhoea which began about two months ago rather severe and causing her to double up. At that time she was unable to lie quietly because of the pain. There was no temperature or vomiting. Four weeks later she had a similar attack but not so severe. One week ago she had her third attack. Leucorrhoea had persisted for three or four weeks before she came in, but not so profuse as at first. She has been married five months, has been sick for three months. She began to menstruate at seventeen, every thirty days two days at a time with some pain, but not very much. There is no history of infection. There is a leucocytosis of 5,000. When she came into the hospital, examination showed that there were no tender points or masses in the abdomen.

The abdominal wall was thin firm and soft. The vagina was narrow deep and distensible. The whole uterus was antiposed and densely fixed. The pelvis was occupied on both sides and posteriorly by dense hard masses which were tender. She had a little fever when she came in it was evidently relatively recent infection. The temperature varied from 99.6° F. to 101° F. on January 25. She was put to bed and kept quiet on a light diet with free elimination with the idea that this would clear up without operative interference but it did not do so. On the 28th the temperature was 101.2° F. This persisted every day, not going below 99° F. at any time. Instead of becoming afebrile she continued to have hyperpyrexia until as recently as February 7. On the 10th of February it was 101° F. This is the type of case referred to when it was stated that if they continue running a temperature pus nearly always develops. Examination on the 15th showed this to be the case in this instance. The left side had cleared up fairly well there was no hard mass on the right side there was a big semi fluid mass which bulged well down posteriorly to the cervix. This morning the posterior vaginal vault was opened and pus evacuated—10 or 12 ounces.

Case 4 is a patient who entered the hospital on February 3. She is one of the few cases of this type over twenty-five being thirty-two years of age. She came in complaining of dysuria, painful menstruation and constipation. One week ago she began to have pain on urination, an acute pain which appeared just before the flow started. Pain on defecation appeared just before the bowels were evacuated. Constipation had been present for six years, leucorrhoea for two years. One week ago the patient menstruated for ten days with the passage of clots. Four days ago there was more bleeding and clots. She has missed no menstrual periods, and has been married four years. She began to menstruate at 12 and since then has menstruated every month for ten days at a time. There is no history of any previous acute onset. There was a leukocytosis of 12,000 when she entered the hospital. Hemoglobin 85 per cent.

Examination of the abdomen showed that it was soft but there was a moderate voluntary rigidity below the umbilicus. The vagina was negative the pelvis was occupied by a soft mass extending downward. Fluctuation was not discernible. It was a question whether she had any amount of pus in her pelvis or not. We thought she had a general pelvic peritonitis but the condition did not give us the idea of any considerable amount of pus in the pelvis. However she had a little temperature, 99.4° F. 99.8° F. 100° F. and that was as high as it went. We cannot always be certain whether we have any considerable amount of pus in these cases an amount that will justify drainage through the vagina or through the abdomen but even with that slight degree of fever I did not like to go into this case through the abdomen. These cases do not

get well properly after being operated upon in that way and peritonization at the time of operation is well nigh impossible. In this case I was not any too certain in regard to her history we must use our own judgment in estimating the value of these histories. Not being certain as to whether there was pus or not I might have left the patient in bed for a few days to see whether the condition would clear up but I also rather favor colpotomy for diagnostic purposes. I do very few exploratory laparotomies but exploratory colpotomy or colpocelectomy I do oftener. I do not like to open the abdomen because I dislike to drain abdominally, so in these cases I do a posterior colpocelectomy and in this one I got a relatively inconsiderable amount of pus only a few ounces in the right tube and none from the left. Since then the leucocytes have gone down to 9,000 the temperature has not gone down entirely. She still runs about the same temperature she had before opening up the pelvis. It ran 99.6 F. 99.2 F. 100 F. on the 12th and on the 14th.

This brings up one point in the question of colpocelectomy in these cases and that is whether in a case in which little or no pus had developed you might not open up the pelvis to infection. I occasionally see a case like this in which the vaginal vault having been opened I fear that perhaps secondary infection has been introduced through the vagina. That may be the circumstance here, but the patient is feeling considerably better and having less pain and aside from the fact that the temperature is not entirely cleared up she is better. As far as the leucocyte count goes, it is of little surgical significance in the absence of fever. Many of these old chronic cases which have pus and a leucocytosis of 12,000 or 15,000 are afebrile for months and are perfectly safe operative cases.

These cases emphasize the value of draining any considerable amount of pus that may be in the pelvis before undertaking operation through the abdomen. Such preliminary treatment certainly makes possible a more conservative operation always desirable in these young women. But its chief value lies in the fact that extensive peritonization is made possible and hence abdominal drainage becomes unnecessary. I very seldom drain a pus tube case abdominally. Besides all this occasionally one of these cases will clear up after colpocelectomy as nearly as we can tell by digital examination. This patient to all gross appearances is well and these cases we let go without any further operation.

#### MISCELLANEOUS CASES

DR. CHANNING W. BARRETT This young woman presents an interesting condition. She came to the hospital in June 1916 for acute appendicitis. She is twenty years of age not married and we found on taking the history that she had had twelve previous operations in the region of the rectum one upon the nose and one on the throat which with the operation for appendicitis made in

all fifteen operations previous to our seeing her. The first operation on the rectum was performed when she was four days old as she had no normal anal orifice. It is not known whether the rectum opened into the vagina at that time or not but perhaps as she was operated on so early there was none. She had had eleven subsequent operations in an effort to establish an anal opening and close up a rectovaginal fistula. She had no control of the feces except when very solid. She had about given up hope but was urged by the interne after her operation for appendicitis to have an effort made to establish an anal opening. It was perfectly plain on examining her that an effort to close the rectovaginal opening with the perineal tissues existing as they did would be a failure. We had to use some other method than merely trying to close the fistula. The fact that in many perineorrhaphies in which there is a rectal fistula a little way up the canal we cut the septum up to the fistula led me to follow that procedure in dealing with this case although a rather normal looking perineal structure was present, except that it ran a little high showing that part of the operative work had been done on the labia majora. Carrying the finger fairly well forward in a vaginal examination we would find the cervix and carrying it backward it entered the rectum. There was a fistula in the region of the normal anal opening which would just about allow a probe to be introduced. That tissue furnishing the perineal structure might be looked upon as so valuable that one would hate to sacrifice it. But when we cut that structure down instead of disposing of any valuable perineal structure we merely had two raw surfaces one to either side of the vagina. The septum between the vagina and rectum now presented. We split the septum and had just the same condition we would have in a complete laceration of the perineum only in the latter case we would expect the sphincter to be present although torn through. In this case we had no hope of having a sphincter in that region, it was somewhat doubtful if a sphincter ever existed there. If it ever did the twelve operations would have disposed of the sphincter muscle. If the sphincter muscle is absent we can make something of a sphincter muscle of the levator ani muscle provided it is drawn up close around the rectum. So after splitting the septum the levators were united making them encircle the rectum after which purse-string sutures were made to draw down the anterior and posterior flaps and the superficial intervening perineal structures were closed. This left a very fair perineal region with the anal opening where the fistula formerly existed. By this method there was no great difficulty in establishing a separate opening for the vagina and rectum as the vaginal and rectal walls were complete. This alone would be a source of considerable satisfaction to a young woman. If we can add to that better control so much the better. The patient tells us she is able to control the feces well and this is

evidenced by the appearance. She has been working all day, and there has been no washing and yet there is no swelling and that has been the case every time I have seen her since she left the hospital. The anal opening is still about the same size. Nothing was done to remove the scar tissue. When the perineum was cut I saw a surface was left on the skin where a fistula was necessary to close it. As she draws a pylon you can see the action of the levator a muscle but the contraction of the sphincter is not evident. The point in losing this was to get the levator muscle to draw this rather close and to make the anal opening small. She can not control solid and semisolid feces and has just little trouble with very liquid feces but she has more trouble in keeping the opening large enough to have good bowel movements. The bowel movements must be kept pretty soft but that is much preferable to having the opening too large. When the finger inserted about half way the stricture draws pretty tight around the finger. We suspect that she will have to have it dilated on. In a while, but she feels that the results have been successful and she is content with the results.

CASE 2. This patient presents few points of interest from the standpoint of the bacteriologist, gynecologist. I have never found that this is a case from the standpoint of the specialist. It is much different from the standpoint of the student and therefore you will find the elements of presentation. The interesting thing is that we have a patient with an enlarged abdomen. If we run quickly over the points of diagnosis we find that it is not a tubercular abdomen, it is not ascites and not a hydrosalpinx. It narrows down to the question of whether it is ovarian cyst or pregnancy. This patient came with the diagnosis of ovarian cyst. I was sent up for operation then when she was examined under the anesthetic it was thought best not to operate at that time. There was history of having her menstruate regularly and that is a interesting point because it sometimes happens during pregnancy but not often. There is a point of interest here in that this patient does not speak English well and the examiner did not speak it well and whenever we have those conditions we must allow little for mistakes in the history. The question of her menstruating every month might be a mistake and upon questioning her further we found she had not menstruated for four months. This size of the tumor could not be accounted for by a four-month pregnancy, so possibly she did menstruate for some time possibly there might be pregnancy and an ovarian tumor accounting for this larger size.

We find on manipulation that it starts with the contour not very well marked symmetrical but not definite very flabby, it definite as the cyst usually is and on manipulation it changes form and contracts. If we wait here carefully we find that every once in a while there is an impulse of heart

sound could be heard so that was considered an extra reason why it was an ovarian cyst. The uterus might be dead but palpation shows that it is not dead. She is forty years of age, the breasts are very flabby and very flabby as they are we would say there is an extra amount of duskliness. The breasts are rather more knotty than we would expect in flabby breast to be. Further we are able by examining this patient with a rubber around the telescope to make out the fetal heart sounds. If we were unable to make these out we would proceed to the vaginal examination and here two months ago she began to have a feeling of enlargement of something presenting at the outlet. It is not the size of the cystocele alone but the soft velvety feel and the dusky color that indicate pregnancy. Large mucous veins present—their color size and softness are suspicious. In one case reported before this society we thought we had an ovarian cyst separated from the uterus, the cervix was very long and large and enlarged above the vagina more than in the vagina, so we thought we felt the whole uterus separated from this very movable mass. The mass was irregular in outline not symmetrical and afterward we found the cause—the patient had twins. She was operated upon for an ovarian cyst and as soon as we got into the abdomen we found it was a pregnant uterus and later she gave birth to twins at full term. Sometimes with a partially developed fetus the operator can get the cervix and some part of the fetus between the hands and the conclusion will be such as to justify the thought that the uterus is being palpated separate from the mass.

On examination in this case nothing of that kind was found. The cervix extended to the mass and then indefinitely was lost in the soft tumor. Of course it was not necessary to examine further when we heard the fetal heart sounds but we took an X-ray which showed the fetus very plainly.

CASE 3. This patient came with a diagnosis of ovarian cyst. She is not on my service and I have seen little of her but there are some things that are interesting. She presents two masses. In the first place it is not properly located for an ovarian cyst. There is a large mass which is very firm lying high on the right. The suspicion of malignancy is furnished in that she presents a long open abdominal scar and yet the tumors still present. An exploratory incision was made. The patient is very much emaciated the tumor does not seem to connect with the pelvis there is rather rigid mass in the pelvis the right side and yet as we feel above it no mass is on the right and the other something different. There is some blood in the urine the bladder was cystoscoped and found coated with phosphat. There was marked redness in other areas. The ureters were not catheterized because with the amount of cystitis which was present it was difficult to see them. The cystoscopist thought best not to try to catheterize her until the cystitis



Dr. Lee's Case 2. Marked diastasis recti.



Dr. Lee Case 3. Marked antiflexion of uterus.

cleared up. This case is thought to be a hyper-nephroma, and the cystoscopist is also inclined to think of tuberculosis of the kidney.

#### OVARIAN TUMOR. DIASTASIS RECTI. MARKED ANTIFLEXION OF UTERUS

**DR. LEE CASE 1.** A girl 16 years old and unmarried came to the hospital because operative induction of a some weeks overdue labor was proposed and for such an operation her father considered hospital care necessary.

She was duly admitted to the obstetrical ward and a history obtained of irregularity of menstrual flow but with also cessation for a considerable time. The fetal heart tones were recorded but the maternal heart rate was synchronous and explained the origin of the error.

My attention was called to her by the interne because he was unable to determine the presentation.

The striking fact immediately recognized was the resistance of this supposedly pregnant uterus. The only pregnant uterus in my experience at all comparable to this ligneous consistency was a case

of ablatio placentae where marked hemorrhage of the concealed type had ballooned up markedly the uterus which was not only of increased rigidity but markedly painful as well. Yet this supposed uterus was right for size, shape and position. The diagnosis was revised. X-ray showed only a uniform shadow through the mass. Careful pelvic examination revealed anterior to this mass and behind the pubis a small mass that was suspected of being the uterus. Operation established the diagnosis of a right ovarian tumor solid and weighing more than eight pounds after removal. This operation was a source of satisfaction to all concerned — especially as it removed a stigma from the patient's name.

**CASE 2.** This patient may present some aspects of interest. We see many cases here that have had antecedent treatment not always wisely in outside hands.

Here we have a case of marked diastasis recti with prolapse of the uterus through the gap. The marked ulceration and excoriation of the abdominal wall due to this is evident. A few months ago a laparotomy was performed and the scar has given away. This shows that operative procedures may

account to the same condition that we find in multiparae, then to a very marked degree.

CASE 3. About a year ago we had such a multipara next to us with marked anteflexion of the uterus who refused any operative use. In a sitting position the uterus was supported by the thighs.

The question of procedure when this patient went into labor arose from the fact that reposition of the uterus to a normal axis was very difficult because of pain and adhesions. A recumbent position was not a viable because of heaviness with a weak heart.

But in a semirecumbent position with abdominal washes verting the position with enemas, a gradual elevation of the head and shoulders and the head entered the pelvis after which the labor was uneventful. In the case just shown we will allow the patient to enter labor and anticipate spontaneous delivery.

#### PYELITIS COMPLICATING PREGNANCY SECONDARY ANEMIA AFTER INCOMPLETE ABORTION OBSTETRIC TOXEMIA ROBERT'S PELVIS.

DR. HENRY F. LEWIS. I will show first two cases of pyelitis complicating pregnancy. Both were observed and studied in consultation with the urologist of the hospital, Dr. Frank M. Phifer.

CASE. The patient has been in the hospital for about six weeks. When she entered she had a temperature ranging as high as 102.5 F and the leucocytosis was very high; there was extreme pain and tenderness in the right lumbar region, extending around to the back and into the right inguinal region. The case resembled one of acute appendicitis in several respects. The pain was so great that morphin was necessary. Our diagnosis lay between pyelitis and appendicitis; therefore operation was delayed.

She was examined cystoscopically on December 2, and the bladder was found perfectly normal. Urine from the right ureter showed a large number of very irritable motile bacilli resembling coliform bacilli. Autogenous vaccines were made. The urine passed *per urethram* also was rich in these bacilli. December 5 she was given 5 million. December 7, 100 million, and December 9, another 100 million of dead bacilli. After the first injection, there was a slight chill, fever of 101.4 F and slight shivering around the heart which persisted for about an hour. After the second there was a very severe reaction, shown by marked chill, weak and faint pulse and depression. This persisted for four hours. The reaction after the third intravenous injection of the vaccine was slight. The first two brought about high leucocytosis.

Pelvic lavage with 1 per cent solution of silver nitrate was given three times a week at first and later once a week. She now comes to the hospital each week for this treatment having been discharged

from the hospital about one month ago. She has also taken ten grains of sodium citrate three times a day.

CASE 2. This patient came in December 17, 1906 with the examining room diagnosis of five months pregnancy and endocarditis. There was considerable dilatation of the heart, temperature of 101.5 F, pulse of 130 (very weak) and extreme cyanosis.

The case appeared to be one of acute endocarditis. She was given digitalin hypodermally and afterward digitalis tincture by mouth. She had severe pain in the right side of the abdomen and back, considerable cough, hemoglobin 40 per cent, reds 3,000,000, whites 6,800, negative blood culture, albuminuria and a slight dullness at one time in the lower portion of the left chest. On January 10, 1907, X-ray showed the lungs patent, the heart slightly enlarged. Repeated examinations of sputum were negative for tubercle bacilli.

On January 1, the heart was greatly improved. From the history and examination we judged her to be pregnant about seven months. Cystoscopic examination January 3 showed the vesical mucosa pale and ureteral orifices not especially congested. On the former date under gas and oxygen anesthesia the coccal metrectomy was introduced and labor started. The next morning the labor terminated with the birth of a recently dead fetus of about thirty weeks. January 31 urine from the right ureter was found to contain a gram negative bacillus resembling the colon bacillus. Urine from the left side was negative.

This patient is improving under lavage of the right ureter and pelvis with 1 per cent silver nitrate solution.

I will next show two cases of secondary anemia following incomplete abortion.

CASE 3. This patient came in January 2 with a diagnosis of abortion recently induced. She is 21 years old, complains of vaginal hemorrhage, weakness and shortness of breath. December 3 she began to bleed, without having had any pain, and continued to do so nearly constantly until she entered the hospital. She came in because she was getting gradually weaker with the continual bleeding. There were no chills, urinary or bowel disorders. She was short of breath on the slightest exertion.

Examination showed a poorly nourished negro girl with mucous membranes very pale, coated tongue, and enlarged tonsils. Pulsation in the carotids was marked, the apex beat was in the sixth intercostal space in the midclavicular line, the lungs were negative, the abdomen was relaxed and not tender from the external genitals a small amount of thin, watery blood was flowing, the blood pressure was 143 systolic and 96 diastolic. The uterus was emptied by dull curettage of the secundina. Gause was packed into the uterus and vagina and removed the next day. Hemorrhage did not return. Blood examination January 3 showed hemoglobin 1 per cent, reds 35,000, whites 12,000. On January 7 hemoglobin was 40 per cent, reds 360,000.

whites 7.200 Yesterday the hemoglobin was 45 per cent.

The treatment has consisted of rest in bed forced feeding with frequent small meals. As soon as the uterus was emptied of the small amount of secundines present the bleeding stopped and has not returned. We have made it a rule here not to empty the uterus in cases of incomplete abortion except for hemorrhage.

CASE 4. This patient is a woman of twenty nine whose last menstruation was December 9 and who entered the hospital February 6 Two weeks before entrance she lifted a heavy tub and began to bleed the next day The hemorrhage was profuse and continued for eleven days. She lost a great deal of blood and became very weak. She was dizzy when she attempted to stand and for a week has had intense occipital headache.

Examination showed extreme pallor of skin and mucous membranes the lips were almost white. A number of the teeth were carious. Incidentally she has a slight enlargement of the thyroid in the median line There was a slight mucopurulent discharge from the vagina on entrance she had not bled for several days Hemoglobin was 10 per cent reds 1,600,000 whites 6,800 She developed acute tonsillitis two days after entrance but the condition cleared up promptly February 15 hemoglobin was 25 per cent She is feeling stronger and is improving in every way.

CASE 5 This is an example of obstetric toxæmia to use the excellent term recently applied to the toxic disorders of pregnancy labor and the puerperium by Dr W A N Dorland.

The patient came into the ward February 14 in a comatose condition, unaccompanied by friends or relatives and so no history was at that time obtainable She was apparently pregnant about 30 weeks. Examination showed a well nourished woman apparently about twenty five years old eyelids closed tongue swollen and lacerated, with flakes of dried blood about the mouth She could not be roused but made movements with all her extremities. Blood pressure was 178 systolic and 120 diastolic. Soon after she entered about 10 a.m., she had a convulsion. We afterward learned from her brother that she had suffered from a very severe headache for two weeks and had four spasms earlier in the morning before entrance. She had also complained of inability to see a little while before the convulsive attacks came on.

She was given morphine and chloral and had no more convulsions from the time of entrance until 3 p.m. as she was being taken to the operating room. Shortly afterward I performed the abdominal cesarean section and delivered a seven months

living baby which soon cried vigorously and is still in good condition in the incubator The woman did very well had no more convulsions and gradually returned to consciousness As you see her now you will notice that she has practically regained control of herself and is in fine condition The tongue is still swollen and tender She did not pass urine last night for several hours but just as we were about to pass the catheter she voided fourteen ounces she has urinated freely ever since. This evening she says she is hungry.

CASE 6 This patient is a negro girl of fourteen a primipara, pregnant at term. The chief point of interest beyond her youth is her pelvis. The measurements show Interspinous diameter 22 centimeters Intercriatal 25 centimeters bitrochanteric 28 centimeters external conjugate 10 centimeters diagonal conjugate 12.5 centimeters This is a degree of transverse contraction resembling the moderate form of Robert's pelvis. The back of the fetus lies far to the right and the head lies transversely just above the brim. The head is fairly well developed and the heart tones are heard about over McBurney's point. The danger of course, is in the position which the head may assume in this Robert's type of pelvis. If the test of labor fails to cause engagement within a few hours it is probable that a cesarean section will be done. It is always well to remember that these young girls seem to undergo labor even with the small pelvic diameters which they often show better than do older primiparae.

#### DISCUSSION

DR. CHARLES E. PADDOCK. In regard to the last case in my experience, which is perhaps somewhat limited young girls of twelve or fourteen have a comparatively easier labor. I think the children are not quite as large. In a colored woman I am of the opinion that we might expect to find a somewhat smaller head in comparison to the pelvis and a head that can be molded more easily than in more advanced pregnancy. I think the size of the abdomen may be accounted for because of the position of the child, and in that position we would not expect the head to engage at the beginning of labor. The head will be higher up under the ensiform.

DR. W. A. NEWMAN DORLAND. I object to terming the pelvis a Robert pelvis. That is an extremely rare form of congenitally deformed pelvis characterized by the absence of both side of the sacrum. This results in a marked lateral contraction of the pelvis. In this patient I would regard the pelvis either as a slight degree of rachitic deformity or more probably a justo minor pelvis.

# BOOK REVIEWS

## A CRITIQUE OF NEW BOOKS IN SURGERY

THE publication submitted this month for review is a very pretty medical art—art in its true sense based on careful, painstaking study diligence in its production and originality.

It is pleasing to the reader to see comprehensive exhaust treatises written by experts who combine their natural artistic ingenuity with scientific facts obtained from almost endless clinical observations and research work. This combination is pregnant with great things as one can readily see by glancing over the pages of any of the mentioned works. The fields are varied, and apparently widely separated but as one proceeds in each the general trend is in the same direction and so one sees the facility in trying to confine study to any one part of the human anatomy. This is just clearly demonstrated in the excellent treatise by Loeb *perforate* *very little* *use it out of* *for* One can say with out a moment's hesitation that the profession has attained a new mastery.

Volume I dealing chiefly with a tommy larva, gynecology and plastic surgery appeared in 1914. The author and his collaborators must be congratulated for their excellent production. There are many points in this work which deserve mention but the outstanding essentials are the beautiful original drawings and illustrations and the arrangement of the text so that the illustrations referred to are instantly before the reader. One must confess and praise his reading book to be constantly referred to, appearing three or four pages ahead behind the page he is reading. This is entirely done away with in Loeb's work. The text is brief yet comprehensive, the type bold and clear and the paper excellent. The book is divided into five chapters. Chapter VII which is the first chapter of volume II deals with the operative surgery of the nasal cavity—the accessory cavities and the hypophysis is approached through the nose and accessory sinuses. Chapter VIII the operative surgery of the pharynx and nasopharynx. Chapter IX endolaryngeal operations. Chapter X operations of the internal ear through the nasal chapter XI surgery of the mastoid process. Every phase of nose throat and ear surgery is included. The text of the different operations is classified into indications contraindications preparation including anesthesia technique of the operation, dressings after treatment and complications and a checklist.

OFFICE 511 BATTERY OF THE NOSE, THROAT AND EAR, B. HENNER, W. LOEB, M.D. with collaboration of W. LOEB, C.V. Medical Company

Following this the different methods of technique are discussed as far as possible in the operation on the nasal septum. It is the author's technique are mentioned the saw operation removal with chisels, heavy knives. It describes the operation of Asch, Wais, (less) Roberts, Slude, Kyle, Price, Brown, Mount and the oral method. Thus we have not only the author's choice but all the standard operations.

In the chapter on surgery of the mastoid, the author discusses the removal of the lateral sinus and jugular bulb drainage of the cisterna magna, picture of the corpus callosum and brain base of a rat and nasal origin.

This volume contains 476 original illustrations, many of which illustrate points in surgical anatomy and associated surgical technique. One cannot lay the book aside without saying that this is the best text of the kind before the profession today.

J. A. W.

OUR present knowledge of the internal secretions is well summarized. Gley's small volume. After reading the book to say we know nothing to glibly regarding the internal secretions in spite of the immense work that has been done would be gross injustice to the respective workers, but we are compelled by the absence of any definite statement to that effect. The author calls constant attention to the fact that it is proved definitely that internal secretions is a tremendously difficult task, although he has reason to believe certain elements exist and that they have an apparent utility. One sentence in the chapter on the distinct characteristics of the internal secretory glands and the principal product of the thyroid gland seems to me to answer the question. The fact that after castration, the epiphysis persists explains nothing and needs, in the contrary to be explained itself.

This little volume affords most interesting reading. It is divided into three chapters. Chapter I. The Concept of Internal Secretions. Its Origin and Development. considers the history more or less of the work that has been done on internal secretions. Chapter II. Distinctive Characteristics of the Internal Secretory Glands and the Principal Products of their Activities is devoted to the study of the broad principles of internal secretions, what constitute an internal secret, the histological

THE INTERNAL SECRETIONS. THEIR PHYSIOLOGY AND APPLICATION TO PRACTICE. By L. GLEY, M.D. Translated from the French and Edited by STANLEY FINKBERG, M.D. New York: Paul B. Hoeber Co.

chemical, and physiological conditions pertaining also discussing the character of the different internal secretions with their classification. Chapter III treats the normal activities of the glands with their respective reciprocal action also their diseased function. J A W

AS the science of medicine advances in its various branches efforts are constantly being made to introduce new methods. This applies especially to diagnosis. But a few years ago the roentgen ray was used almost exclusively in bone work or for the localization of foreign or opaque bodies. Soon the field broadened to include the chest, the gastro-intestinal canal, and the urinary tract. Now in the hands of the experienced and careful operators it affords a most useful and necessary adjunct to the diagnosis of gastro-intestinal disease. The book by Carman and Miller<sup>1</sup> is indeed opportune.

The authors from their vast experience with a large amount of clinical material have elaborated a system of gastro-intestinal examination which to say the least is most comforting to the surgeon and the internist. The information gained by reading this volume is useful not only to the roentgen ray operator but to the surgeon, the internist, and the general practitioner.

The authors take pains to tell you of the apparatus the technique of plating and screening and the opaque mixtures which in their experience have given the best results. They then take up the anatomic structures, beginning with the oesophagus giving the individual technique of examination and the normal organ with its variations and the pathological changes which can be demonstrated with the roentgen rays.

The chapters devoted to the stomach deserve exceptional consideration. The normal stomach is discussed from the point of habitus, tonus, form, tone, position, size, contour, mobility, flexibility, the gas bubble, secretion, peristalsis and motility. The abnormal stomach is next considered giving the variations in the same manner. Every condition is illustrated by photo-plates which are very clear and instructive. A chapter is given to gastrosplasm drawing attention to its importance in the diagnosis of chronic appendicitis, gall-bladder disease and allied conditions. Two chapters are assigned to gastric ulcer and carcinoma and the detail is most interesting and instructive. In this as well as in practically all of the abnormal conditions encountered there are added case histories with illustrations of roentgen findings and operative diagnoses.

The chapter on duodenal ulcer although comparatively brief is most instructive. They give as the roentgen signs in duodenal ulcer, direct signs including deformity of the duodenal contour, indirect signs including alteration of gastric tone, alteration of gastric peristalsis, alteration of gastric motility, gastrosplasm, tenderness localized to the

duodenum. Each is discussed and illustrated in detail.

Cancer and tuberculosis of the colon as well as diverticulitis, colitis, chronic appendicitis and miscellaneous lesions of the colon, gall bladder and liver are presented in a most fascinating way. There is an extensive discussion on constipation and intestinal stasis as presented by Lane Jackson, and others, and the information that can be gained by roentgen ray examination.

The authors quote freely from such authorities as Holzknecht, Haudek, Case, Hertz, Jordan, Schwarz, Kaestle, Barclay, Cole, and many others.

Those familiar with and who are ardent supporters of the roentgen examination of the alimentary canal may gain a great fund of knowledge from this work, and those who look with doubt upon the subject may be relieved of a certain amount of not ill of their suspicion and mistrust. J A W

WHEN at the outset of our medical course we attempted to unravel the mysteries of the brachial plexus and to acquire a permanent impression of its source and destination two names seemed to find an abiding place in our memory—Wrisberg and Bell. Median and musculospiral might be forgotten but Wrisberg and Bell remained with us. They had lived once, and studied anatomy, perhaps they had been confused as well. In the future they are to live only in encyclopedias and memoirs and we can only deplore their passing while we recognize the necessity of the change.

Dr. Eycleshymer asks in his preface to *Anatomical Names*<sup>2</sup>: "Since the B.N.I. has become the language of the anatomists may they not hope for the co-operation of the clinicians in clearing the field of thousands of useless synonyms? At the present day it is scarcely possible to find a student's text-book on any clinical subject which evinces the slightest concern as to the uniformity of its anatomic terms. His book offers a real stimulus and aid to the task."

To the student in medicine (not alone the undergraduate) and especially to the man who takes an active part in the teaching of medicine, *Anatomical Names* will prove not only of help but of real interest. The preface recounts briefly the development of anatomical nomenclature of the tendencies which helped to make it hopelessly ambiguous and confusing, the individual efforts at correcting that tendency, and finally the work of the Anatomical Society which culminated in the formation of the Basle nomenclature.

The translation of His original report to the Anatomical Society reads like a historian's tale. Through out one is constantly impressed by the widely divergent opinions which met Krause and his associates at every turn and by the painstaking care which

<sup>1</sup> ANATOMICAL NAMES. ESPECIALLY THE BASLE NOMINA. A. TORICAL. BY ALBERT CHENEY EYLESHYMER, B.S., Ph.D., M.D., ASSISTED BY DANIEL MARTIN SHOEMAKER, B.S., M.D., WITH BIOLOGICAL SKETCHES BY ROY LEE MOORE, A.B., Ph.D., Wm. Wood and Company, New York.

<sup>2</sup> THE ROENTGEN DIAGNOSIS OF DISEASES OF THE ALIMENTARY CANAL. BY RUSSELL D. CARMAN, M.D., and ALBERT MILLER, M.D. Philadelphia and London: W. B. Saunders Company. 97



they expended on the small details of their task. The report includes the entire list of names suggested by the committee with numerous explanations and notes accounting the reason for the final choice in those cases in which a number of alternatives suggested themselves. The section devoted to neurology amounts to a comprehensive summary of the anatomy of the brain and spinal cord.

The second portion of the book is devoted to brief biographical sketches of the men who have made anatomy sketches that make one realize anew that anatomy is not merely an inert mass of knowledge, but the expression and achievement of living men who wondered and worked and discovered.

The largest portion of the book consists of a complete index of anatomical names, new and old, including proper names, with cross references indicating their equivalents in the Basle nomenclature. The names adopted by the Basle convention are distinguished by heavier type so that the student can rapidly find the meaning of any name as well as the Basle equivalent for the older synonym.

Dr. Eycleshymer's book should prove not only of help in the general adoption of the universal nomenclature but a real stimulus to the human interest in the science of anatomy. S. L. K.

AS medical science advances specialization furnishes an increasing opportunity for thorough and exhaustive work in any particular field. Medical literature naturally follows the same trend. Subjects such as diseases of the breast, infections of the hand, and fractures furnish an opportunity for monographs that approach completeness in a single volume. The subject of traumatic surgery on the other hand possesses an inherent weakness in that real difficulty it presents of determining what part the traumatic factor plays in the etiology of many surgical conditions.

Dislocations and fractures obviously are traumatic and this section of Dr. Moorhead's book is the best feature of the volume. The pathology of different fractures is well shown, and the entire section is finely illustrated with roentgenograms and photographs.

Are infections traumatic? Infections of the hand are considered so and discussed at some length. Peritonitis and osteomyelitis on the other hand are disposed of in six pages. Arthritis is considered in four pages, but twelve pages are used in showing

Dr. Murphy's treatment of its sequel, ankylosis and ten more in roentgenograms of the blood supply about the joints.

Is hernia traumatic? The author discusses the question at some length from the medicolegal standpoint and concludes that trauma is the rarest of all causes. Appendicitis, uterine displacements, abortions all come in for a share of comment in such a way as to leave the annoying impression that the subject has been deemed unworthy of serious consideration and thrown aside untouched. Discussion of the traumatic neuroses, eye and ear standards and medicolegal phases help to deepen the feeling that in attempting to cover so diversified a field much of the possible value of the book had been dissipated. S. L. K.

AS students in medical school, we curiously examined specimens of gunshot wounds in the pathological museum as relics of bygone ages and little dreamed that in our own time the whole subject would be given a new and terrific impulse by the great war.

Colonel LaGarde's revision of his book on military surgery has afforded him the opportunity of including in it some of the recent advances in military surgery. Most important obviously are the methods of dealing with infected wounds, by irrigation with hypochlorous acid solution with hypertonic salt solution and by primary excision and suture. The omnipresence of infection in wounds of every sort is emphasized by the high percentage of infections following effusions of blood into the pleural cavity, more than one-third (48 of 120) in the series of cases reported by Bradford and Elliott and almost one-half (69 of 160) in a second series.

Two chapters devoted to technical considerations are followed by chapters on the symptoms, pathology and treatment of gunshot wounds in general and these by a consecutive chapters on wounds of the head, spine, chest, abdomen, peripheral nerves, joints and bones. A rather technical description of the X-ray as used in the United States army forms the concluding chapter. No mention, however, is made of the newer devices in roentgenography in use by the armies in Europe. The whole volume is splendidly illustrated with roentgenograms and photographs and should prove a valuable addition to the subject of military surgery. S. L. K.

GOODBYE FIGHTERS: HOW THEY ARE INFLECTED, THEIR COMPLICATIONS AND TREATMENT. Edited by Colonel Louis A. LaGarde. New York: William Wood & Co. 1918.

TRAUMATIC SURGERY. By John J. Moorhead, B.S., M.D., F.A.C.S. Philadelphia and London: W. B. Saunders Company. 1918.





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# SURGERY, GYNECOLOGY AND OBSTETRICS

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## SURGICAL EXPERIENCES IN THE PRESENT WAR<sup>1</sup>

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### I GUNSHOT WOUNDS AND THEIR TREATMENT<sup>2</sup>

**S**URGEONS who were responsible in the early weeks of the present war for the treatment of the wounded soldiers coming home from France are I think never likely to forget their experience. There were wounds of many dimensions and of every tissue all characterized by the most profuse and offensive suppuration. No one in active work had ever met with cases like all of these. Whether a surgeon had practiced aseptic or antiseptic surgery he had been able to secure with gratifying constancy a blameless healing of the wounds he had made, he had rarely seen a profoundly septic wound and the methods he had at his disposal for dealing with them were almost always easily capable of reducing and controlling the infection. Suddenly he was confronted with a long succession of cases in which a raging and often a rancid suppuration was present, and he found that all the old remedies upon which he had so comfortably and so confidently relied were hopelessly

inadequate and futile. A challenge was so to say thrown to the profession, and I think we may now with due modesty claim that it has been splendidly and triumphantly met. Rebukes and taunts at our incompetence were not seldom heard in those far off days. We were asked if Lister had worked in vain we were told we had failed to learn the lesson he had spent his life in teaching.

It is interesting to read again the works of Lister and to see how helpless he felt himself in dealing with putrefactive processes once firmly established in a wound. Lister every where distinguishes between the prophylactic and the therapeutic uses of antiseptics. All the marvelous achievements of modern surgery are due to the adoption by surgeons the whole world over of the principle of the prevention of infection in wounds about to be made as distinguished from that of the subduing of an infection already rampant.

Lister writes 'The original idea of the antiseptic system was the exclusion of all

<sup>1</sup>The opinions expressed in the following papers are based, not only on my own experience overseas and in England, but upon the work I have seen in a large number of hospitals, both in the French Army and in our own, and upon the many discussions I have had in many places and on many occasions, with my colleagues. I desire especially to thank in the French Army, Professors Tuffier, Gosset, and Pierre Duval. I may most appropriately quote: 'I have gathered, praise of other men's flowers, and nothing but the thread that binds them is mine own.'

<sup>2</sup>Read before the Clinical Congress of Surgeons of North America, Chicago, October 16-17

microbes from wounds. Again During the operation, to avoid the introduction into the wound of material capable of inducing septic changes in it, and secondly to dress the wound in such manner as to prevent the subsequent entrance of septic mischief. Again

In wounds already septic attempts are made with more or less success to restore the aseptic state. Again In speaking of the anti-septic system of treatment I refer to the systematic employment of some antiseptic substance so as entirely to prevent the occurrence of putrefaction in the part concerned as distinguished from the mere use of such an agent as a dressing

The distinction between the preventive and the curative use of antiseptics is in many respects that existing on the one hand between the power of a germicide as determined by experiments *in vitro* and on the other hand its apacity to destroy organisms when it is introduced among the living and the dead tissues of a wound. In the former there is a direct conflict, a clean fight, between the microbe and the chemical agent. Few or none of the many intervening conditions are present which have to be considered when a bactericide is introduced into a wound cavity wherein there are a multitude of actions and reactions which even now seem very obscure and are so often conflicting

When after the lapse of many weeks from the outbreak of war there came a full appreciation of the several circumstances which had to be reckoned with when a soldier was wounded it was recognized on all hands that a new and grave problem had arisen which needed urgently for solution. What then were the several new factors that had to be considered

In the early days a very large number of the wounds were inflicted by rifle fire. The German bullet has a muzzle velocity of approximately 1000 yards per second. In the first 800 yards or thereabouts the flight of the bullet is not steady but wobbling. There are three movements a movement forward along the line of flight a rotary movement, in which the bullet spins round on its longitudinal axis as a result of the rifling of the barrel and a third movement, a *mouvement de bascule* of such a character that while

the point of the bullet keeps steady the base of the bullet is moving round a circle, or an ellipse of a gradually diminishing size. The result of the last form of motion is this that when the bullet impinges upon any substance even the soft clothing or the flesh the infinitely brief arrest of the point which strikes first allows the base which is of course much heavier to overtake the apex and the bullet then lies sidewise or begins to turn over and over as it ploughs its way through the soft parts. In this early part of the trajectory the missile has of course a great momentum it is a heavy bullet traveling with great velocity. The consequence is that the damage inflicted is not confined to the track it rudely makes through the limb the parts around the track are damaged also often to a great extent and microbes are driven deeply into all adjacent tissues. Every wound therefore caused by a bullet at short range consists not only in a visible tearing and destruction along the path the bullet has followed, but in a dead zone everywhere surrounding that track — a zone in which death or destruction or disintegration of the parts has occurred by reason of the tremendous concussion produced by the bullet as it tore its way clumsily through the tissues. Sir Anthony Bowlby has illustrated this by a series of exemplary instances. In one of these the kidney was wounded in its lower pole the upper pole appeared normal to the naked eye yet on microscopic examination the tubules were seen to be disorganized. Other examples of the widespread damage inflicted are quoted in his Bradshaw lecture. And even that is not all. The momentum of the bullet is such that to every thing it encounters it imparts some of its own velocity. As we all know shreds of the clothing or belt or the contents of the pocket, may be carried deeply into a wound. So also are pieces of skin or muscle. And if the bullet should chance to strike a bone the bone is not only broken into many fragments, the splinter fracture but to all fragments there is conveyed enough of the momentum of the bullet to convert them into projectiles also capable of tearing a way into the softer tissues. Many of the wounds therefore

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were deep irregular in shape with large or small cavities of the variety the French term 'anfractuous'. Into these recesses blood escapes and owing to the tearing and unequal retraction of cut muscles pools of fluid may be shut off from the main track of the wound and form an ideal breeding ground for all micro-organisms especially those which are anaerobic.

If a rifle bullet is not checked in the first 600 yards of its flight it begins to steady down and probably when it has traveled 1000 yards it is moving evenly. An injury inflicted then is of a quite different character. The bullet cleaves its way through the soft parts bores a neat hole through a bone and little destruction is done. We see many cases where the chest or abdomen are traversed from side to side or where the neck has been pierced and miraculously no real damage has been done. Examples of this form of injury were of course common enough in the South African War. They have been less frequent in this war because the range has often been shorter and the bullet in respect to velocity and weight is different.

During the last two years a very large proportion of the wounds have been inflicted by shrapnel bullets hand grenades or shell casing. The immense velocity of the projectiles especially when a high explosive shell bursts their irregular shape their pitted surface and sharp edges all combine to cause wounds of very diverse forms. The track is a distorted one, the parts around it are bruised and battered or dead and the infection carried into the wound by a piece of metal or cloth has unrestricted opportunities of spreading rapidly. In many cases large areas of the limbs or trunk are blown away. The wound remaining shows a shattered and irregular surface the muscles are torn and crushed or pulped and lose their structure. They dry rapidly on exposure and therefore fall easy victims to a bacterial attack often of great ferocity.

The condition of the battlefields of Flanders and of France accounts for the quality of the infective agents. Many parts of the lands over which the fighting has taken place both before and since trench warfare set in were

cultivated assiduously by the rural inhabitants before the war. Probably no soil in Europe has been more liberally manured in efforts at intensive cultivation. Certainly no contact between the soldier and the soil has ever been more intimate or more protracted. In the winter the whole fighting zone is in Sir Douglas Haig's phrase a wilderness of mud. In the summer it rivals the desert in a sand storm dust is everywhere. It steals into the eyes and nose and throat and ears it grimes the face and hands it fills the hair it penetrates every vestment. Every projectile passing through the garments to the body will certainly be covered with the mud or dust in the clothes and with the many organisms that a respite from ablutions has allowed to penetrate the skin. All bacteriologists and surgeons are now agreed that no influence perpetuating infection in a wound is so malign as that which is harbored in the torn fragments of clothing. The physical condition of the soldier himself when he is wounded no doubt plays an important part in exalting the virulence of any infection which may settle upon him. Though in the best of health and physical condition at the moment of attack he may by the time he is wounded have suffered great fatigue and bleak exposure for hours or even days before succor comes to him. The organization for the collection and despatch to the field ambulances and casualty clearing stations, of wounded men is probably as perfect as any endeavor can make it. But there are times, especially in a push when a man may lie out undiscovered for long periods. Not infrequently by reason of such causes and on account of pain and hunger and loss of blood he may be reduced to a state in which his power of resistance to a bacterial attack is greatly impoverished.

*Bacteriology.* The bacteria infesting the wounds in France have been studied by Wright, Fleming and others. The general conclusion drawn from their work is that the micro-organisms as might be expected, are those found in highly manured soil they are that is to say of faecal origin. Wright suggests with his customary fecundity of invention the new names *aerophytes*

for those organisms which will grow in normal serum, streptococci and staphylococci and serosaprophytes for those which can only grow in digested albumens. The native albumens of human serum are protected from bacterial development at their expense and Wright points out that, if this were not so human life would have been impossible. Among the serosaprophytes are the larger number of the organisms found in wounds including all the anaerobes the bacillus of Welch the bacillus of tetanus the enterococcus, a streptococcus of intestinal origin described by the French, the bacillus coli and putrefactive bacilli X and Y which are the cause of the foul odor often met with in wounds. There is often a wisp bacillus and a diphtheroid bacillus appears in later stages of the infection.

All these micro-organisms find a most fertile medium for their growth in wounds of the character I have described. In every anfractuous wound where the recesses are many and intricate blood or serum may be poured out tryptic digestion begins as a consequence of the destruction of the leucocytes peptones are formed and bacteria finding everything to their liking grow apace. From many of the wound surfaces the circulation has been cut off by the powerful stunning effect of the blow given by the projectile and gangrene and sloughing make haste to develop. During the first 4 to 6 or in some cases even 8 hours, few organisms or none can be recovered from the wounds either by smear methods or by cultural methods. The organisms are there nevertheless, and given the prodigal fertility of the soil in which they are sown will quickly show the evidence of their growth. In this brief early period the wound is said to be contaminated in all later periods infected.

Against this attack made upon it by immeasurable millions of organisms, how does the body protect itself? The chief defense is in the blood serum and in the leucocytes (phagocytes). The capacity of these two if only they have an adequate chance, may be said to be almost illimitable against all organisms but the streptococcus. The serum possesses strong bactericidal powers of its own

the phagocytes can devour bacteria greedily. But in exerting their powers, both serum and white cells are apt to undergo degradation. The leucocyte breaks down and its power of tryptic digestion is then exerted upon the fluids around it and peptones are produced in quantities which make easy the growth in them of all forms of bacteria. Moreover the surface of the wound soon becomes lymph-bound. A mesh of fibrin entangles the blood cells and a sort of matting of coagulated lymph spreads over all the surface. No fresh serum can then reach the wound nor are fresh leucocytes available for the attack. The infective process can then proceed apace unhindered by those powerful natural defenses which for the moment have quite broken down.

#### THE PRINCIPLES AND METHODS OF TREATMENT OF GUNSHOT WOUNDS

*a Primary closure* Everyone to whose lot it has fallen to undertake the surgical treatment of wounds in this war will agree that the most urgent need is to secure their complete closure at the earliest possible moment. In the early hours during the period of contamination, it is now the common practice to excise freely all damaged and dead tissue if possible in one piece. This requires some skill and no little practice to do excellently. The most careful preparation of the skin and the parts around the wound is a necessary antecedent to any operative measures. The wound of whatever type, is excised together with a wall not less than one third inch around it. In order to make certain that all the walls of the original wound are excised Wilson Hey has suggested, and has long employed a method of staining with brilliant green which is injected into all parts of the wound and allowed to remain not less than two minutes. The staining of a wound not only makes a more thorough removal possible but it also indicates those parts which can not or may not be removed, to which therefore a simple mechanical cleansing must be more particularly directed. When staining has been thought unnecessary he tells us the final results are worse. Staining in every case is a help it is never a

hindrance. The walls of the cavity remaining after excision should bleed every where perfect hæmostasis is then secured. Every soiled instrument or glove is at once discarded. The wound may then be stitched up completely without drainage and with much confidence may be expected to heal well. The cases coming to the base hospitals in England show that in a great variety of injuries this method of the primary closure of wounds is meeting with a very remarkable success. If the operation is carried out with scrupulous exactitude and with something near to technical perfection in cases of contaminated wounds probably not less than 90 per cent will heal by first intention. The failure occurs in those cases where a piecemeal removal of the infected wall has been carried out where that is to say there has been frequent re-infection of the newly made raw surfaces.

There has been in all armies a certain timidity very natural and perhaps from many points of view very desirable in carrying out the method of primary closure. No one who has worked even for a brief period in the armies in France can have failed to realize the desperately serious results which come from the injudicious closure of septic wounds. Gas gangrene for example may develop in an amputated stump if even one stitch is put in to approximate the flaps. And there has consequently sprung up on all sides a fear of the premature closure of wounds. But recent experience would seem to show that at least in the early cases in cases reaching a well-equipped surgical unit say within 8 or 10 hours in the period of contamination rather than of spreading infection a mechanical cleansing of the most thoroughgoing kind carried out ruthlessly and rapidly will allow the great majority of the cases to be closed with an excellent chance of primary union. There can no longer be any doubt that many of the cases which have proved so successful under the Carrel Dakin method applied during the first 6 to 8 hours would have closed equally safely and far more rapidly under the method of immediate suture and that consequently a certain degree of suffering and much expenditure of time

and no little expense would have been saved. To put this statement in what may seem an extreme fashion it may be said that the Carrel Dakin method has achieved its greatest triumphs in cases where it need not in fact have been applied. But if this opinion is true it must at once be admitted that one of the chief experiences which have led to its realization is the practice of this method with great success during many months. More than ever are we now confirmed in our strong opinion that it is the primary mechanical cleansing after thorough exposure and with every precaution and care that is the supreme necessity in all cases and that this alone if complete will allow the natural defenses of the body to secure the blameless healing of the wound. In doubtful cases indeed in any case a small drain of a few strands of silk worm gut may be left in the corner of a wound closed by primary suture. All cases are watched carefully for a few days. If the temperature remains high, or if the wound on being uncovered looks angry, inflamed and especially if a streptococcus infection is found the wound must be opened up completely and treated by one of the methods to be presently described.

*b. Secondary closure.* If however owing to one or more among a great diversity of circumstances the patient arrives at a base hospital with a freely suppurating wound the problem is quite different. The chance of primary closure has passed away perhaps long ago the wound now may be covered sparsely or thickly with sloughs of varying size and in various stages of detachment. Layers of lymph adhere to one point or at many to the wound surface and the discharges are thick purulent and offensive. The problem here is first to secure a healthy and relatively uninfected surface and secondly to close the wound by suture on the earliest prudent occasion. What are the principles which we must now put into practice? For purposes of tabulation and description they may be spoken of as physiological and antiseptic though as I shall indicate the difference between the two may not be so sharp as such a precise and limited statement might appear to indicate.



*Physiological methods* These owe their origin to Sir Almroth Wright. The problem Wright set himself to solve in the case of the septic lymph bound wound was that of rendering available once more all the natural defensive mechanisms possessed by the body fluids and tissues, and of exalting their power by bringing them into play in far larger quantities than are usually at our command and in a condition which, as a result of vaccine injections or because of the increased antitryptic power of the blood serum of a wounded man finds them greatly augmented. We have he says to promote the destruction of the microbes which have been carried into the deeper tissues we have to resolve the infiltration in the walls of the wound and to get rid of infected sloughs we have to prevent the corruption of the discharges and to inhibit microbic growth in the wound we have to be constantly on our guard in order to prevent those active and passive movements which propel bacteria along the lymphatics and which carry poisonous bacterial products into the blood and finally all this being done we have to get rid of the surface infection promote the processes of repair in the wound and bring together the wound surfaces so that they may heal.

How are these various tasks successfully accomplished? The blood serum as Wright has shown possesses certain remarkable properties. Mechanically it is the agent by which phagocytes are washed on a rising tide into the wound and chemically it has a powerful bactericidal efficiency against all micro-organisms but the serophytes streptococci, and staphylococci (the anaerobic organisms that is to say) are destroyed by it. The phagocytes as Metchnikoff long ago showed us can devour and digest micro-organisms of all kinds but tried beyond a certain point they perish in the fight, and liberate at their death a ferment, trypsin which digests the native albumens in the serum converts them into peptone and therefore adds enormously to the cultural value of the wound discharges. The blood however is normally antitryptic, and this quality appears in cases of infection to be increased—there is an antidote that is to say to the local defeat of the phagocytes

and the consequences attaching thereto. The coagulability of the serum is also increased with the result that a felting of fibrin forms on the walls of the wounds and prevents the access to the wound of reinforcements of serum and of cells. Wright's method consists in the application of a hypertonic solution of salt, 5 per cent or anything over that, together with  $\frac{1}{2}$  per cent citrate of soda (this is not necessary). The principle of the hypertonic method is to make use of the bactericidal power of fresh serum which is encouraged to flow from the wound surfaces by the application to them of a more concentrated saline solution than blood serum. A process of osmosis is at work. It is argued or rather asserted, which is not the same thing that serum is a fluid which will not osmose but the fact is indisputable that when these strongly saline dressings are applied the discharge from all the wound surfaces is increased enormously in quantity. The patient is often compelled to drink freely so considerable may the drain of the fluid be. The discharge from the wound after the first few hours becomes clear and within 3 or 4 days may be found sterile or of low bacterial content. The streptococcus is by far the most resistant of all micro-organisms after 3 to 5 or 6 days it is often the only germ remaining. As I go round from one hospital to another or from one ward to another I think I am generally able to pick out the cases which are being dressed by Wright's solution. The granulation tissues have a fuller deeper color and the surface looks cleaner than when any other form of dressing is being used. The blood serum has now done its work. During this time the phagocytes have been inhibited in their action and even destroyed as I shall presently mention. It is their aid which is however supremely necessary in the attack upon the serophytes. The hypertonic solution is therefore changed for an isotonic solution which encourages the migration of leucocytes and leaves them to deal with the streptococci and staphylococci (generally few in number) that alone remain in the wound. When bacteriological examinations reveal that the wound is clinically sterile it may be sutured or its edges approximated by strapping

The action of hypertonic saline solutions is complex and its virtues conflicting. It attracts water from the blood together with all the protein substances contained therein. It inhibits leucocytic migration, prevents phagocytosis, disintegrates those leucocytes with which it is brought into direct contact and thus sets free a tryptic ferment which digests the albumens of the blood serum. It delays or prevents the action of this very ferment which it has caused to be liberated. It inhibits coagulation and so prevents the sealing up of the channels through which lymph pours into the wound. It appears definitely to inhibit bacterial activity and propagation.

Various modifications of Wright's original procedures have been made. Before I left France for the first time in March 1915 we had begun to use salt tablets wrapped in gauze in the wound at the suggestion of Colonel Lawson with the intention of keeping available in the wound cavity a constant supply of a hypertonic solution. This method was afterward widely used and warmly advocated by Colonel Gray and Major Hull who designed the salt pack a most useful and valuable form of dressing. After appropriate cleansing a wound may be filled with a number of salt packs protected by a few layers of gauze from actual contact with the granulating surfaces so as to avoid sloughing and left for 8 or 10 days. The dressing becomes very offensive but on its removal a bright even and healthy layer of granulations covers every part of the wound. This method is of great value in many cases of secondary hæmorrhage where only smaller vessels are involved and is of the greatest service in those cases where transference of the patient from one hospital to another is necessary. Colonel Sargent has recently used an ointment made of vaseline with 5 per cent salt added thereto after a thorough cleansing and a sparing application of this preparation a secondary closure of the wound will be followed by healing. The various papers of Sir Almroth Wright on physiological methods and on the treatment of wounds have helped us to realize better than ever before the immense complexity of the problems con-

cerned with the healing of septic wounds and clearly to understand the principles upon which we must rely in order to promote union.

*Antiseptic methods.* Before any discussion with regard to antiseptic methods can be productive of good we must ask ourselves the question: What is it we expect an antiseptic to do in an infected wound? The answer most commonly given by those to whom I put this question is that an antiseptic acts by destroying bacterial life. But a great many qualifications must be given before such a reply can receive even a slender acquiescence. The problem of the action of an antiseptic in an infected wound is far too complex for a simple and ready answer. We know in truth very little even now of what goes on in all parts of a septic wound. But we may be quite certain that an antiseptic is never monotropic, engaging one substance only. It may have an affinity for the tissues forming the wall of the wound, for the serum or for the leucocytes or for the gauze packed into the cavity of the wound or with the dressings applied to the surface. It may have opposing effect on different parts of the wound; it may for example increase proteolytic digestion in its action upon sloughs and it may inhibit or prevent this process by its effect upon leucocytes and their emigration. An antiseptic however potent *in vitro* may be quenched by the other substances I have named and fail to influence the bacteria in any direct way. Moreover the bactericidal power of an antiseptic is no criterion of its penetrative power. Its bactericidal power is at once profoundly modified by its contact with albumen with which it most eagerly combines, as is also its power of diffusion, and therefore of reaching in a still active condition all the crannies and chinks among the recesses of the wound. The direct germicidal effect of any antiseptic is therefore almost certainly very much smaller than many of us had supposed and is confined chiefly or exclusively to those bacteria which are lying bare to its attack in the open wound. I have moreover always thought it very difficult to credit the supposition that an antiseptic, however applied, can have an efficient action

against micro-organisms in a wound without producing also a very harmful effect upon the body tissues and fluids. Or in other words exclusive reliance upon an antiseptic to act as a germicide is a negation of all dependence upon the principles of physiological reaction of the tissues to a bacterial attack. These points will emerge more clearly in connection with a brief description of the various methods of antiseptic treatment adopted at the present time in the zones of the war.

Among these pride of place will cheerfully and gratefully be conceded to the Carrel Dakin procedure. It consists as all surgeons now know of a free mechanical exposure and cleansing of the whole wound. This is so easy to say and alas so difficult in all cases to carry out adequately. The wound so made is then lightly packed with gauze into which a number of Carrel's tubes are laid through these tubes at intervals of about two hours Dakin's fluid is instilled. Probably full realization of the need for careful preparation and testing of Dakin's fluid is not universal nor of the rapid deterioration in its potency if it is allowed to be heated or exposed to the air or stored in transparent glass bottles in warm places. The method allows of the early secondary closure of wounds at an average period of 8 to 12 days and coming when it did before the end of the first year of the war it is no exaggeration to describe its effects upon the treatment of wounds as revolutionary.

In what way does the Carrel Dakin method act. Are its effects produced by reason of the strongly antiseptic properties of Dakin's fluid or because of other properties not directly concerned with the killing of micro-organisms? Or is the most excellent technique for which we cannot be too grateful to Carrel chiefly responsible in that it necessitates a greater general care of the wound a free opening of all recesses and that constant supervision which detects at the earliest moment any harmful development on the granulating surface. If strict dependence is placed upon the microbial curve it would appear that the author of the method believes that progressive sterilization of the wound is produced by the chemical action of Dakin's

fluid upon the bacterial flora. The reduction in the number of organisms even irrespective of their nature, is held to be the index of the germicidal effect of the fluid applied. Even when comparatively small quantities of a potent bactericidal fluid like that discovered by Dakin, are instilled frequently into wound cavities covered by sloughs or granulations the killing of microbes can hardly be of serious consequence. For these organisms can propagate themselves at a rate with which the most powerful germicide could hardly catch up however frequently or adequately supplied. I can easily conceive of an antiseptic using the word in its clinical sense which is not in the smallest degree germicidal. I can understand that is to say that a wound however gravely infected may by the application of some chemical substance be deprived of its bacterial flora, in very great measure, or even completely though no single micro-organism is killed by this substance. An antiseptic, if not germicidal (that is not acting chemically upon the substance of which bacteria are composed) might yet render the wound sterile either by destroying the pabulum of the bacteria so that they are unable to flourish and to propagate or by exalting those normal powers of resistance possessed by body tissues and fluids or by holding up the bacteria until those powers without increase are capable of destroying or dispelling the infective agents. Or does the action of chemical agents on the leucocytes so alter their metabolism as to produce substances which cause degenerative processes in the bacteria? That is an evolution forms of bacteria developed by the relationship of these agents to them? The most striking effect visible to the eye in a wound treated by the Carrel Dakin method is that the surfaces are cleaned very rapidly. Dead tissue even large sloughs are quickly digested away and the surface becomes smooth, clean and bright red in color. In a wound not yet clean in all its parts a very different microbial curve can be drawn if smears are taken from the smooth red portion of the surface and from the edge of a slough. It is the dead tissue in the wound that keeps the septic processes going. If this is destroyed bacte-

rial profusion and virulence both rapidly diminish until the wound is clinically sterile." If therefore a substance could be found which without having a directly noxious effect upon bacteria could rid the wound of all dead tissue and allow the natural defensive mechanism to have a free chance it is probable that the wounds would heal as kindly as they do under the Carrel Dakin system.

What appears to be a fulfillment of this supposition has been published since the above paragraph was written. Donaldson and Joyce<sup>1</sup> describe a non pathogenic spore-bearing anaerobe which acts apparently in virtue of its proteolytic powers only on devitalized tissues and possibly on tox albumens and appears to possess no power of attacking healthy tissues. The powers of this organism are directed toward the removal not only of the grossly damaged tissues but it succeeds also in attacking the microscopically damaged structures. As a result, the body forces are freed from the constant menace of septic poisoning and are thus allowed to commence the work of repair. It is therefore an arguable proposition that Dakin's fluid as applied by the Carrel technique does not act as a germicide but rather as a proteolytic agent, as an agent destroying those parts of the wound on which alone or chiefly organisms can find a place to propagate. It is after all therefore the mechanical cleaning of the wound which is of the greatest importance, and the action of Dakin's fluid is perhaps very much the same as that of the surgeon's knife in those cases where the wound is ex-

posed. It has long been known that the removal of the dead tissue is not necessary for a healing. By first intention though the quality of that healing varies decidedly according to the relative infectivity of the wound. The fewer and less harmful the organisms the more blameless is the healing. Surgeons who have worked as surgeons should work with a bacteriologist at their elbows will admit they have frequently closed wounds which were proved to contain micro-organisms and yet have obtained a union of the wound that was good. Until I adopted my present technique this was a frequent experience but many years ago I began (I was I believe the first to begin) the covering of the skin by tetra cloths which overlapped the skin edges and since then I can be certain that in all clean cases the wound remains sterile to the end of the operation and a flawless healing can be confidently expected. Carrel has coined the phrase clinical sterilization to indicate that condition in which organisms are so few that the wound can safely be closed and good healing obtained. Regard should however be paid not only to the number of the microbes but to their nature. I do not like to find a streptococcus present when the day approaches for the secondary suture of a wound. Carrel's method must rely at the last upon the living properties of the tissues to destroy or render innocuous the organisms still remaining in the wound when it is closed. It is true that they are few but they are there nevertheless and must be overcome if the wound is to heal and to remain healed. What most surgeons have learned since the introduction of this technique is that which those surgeons who worked with a bacteriologist by their side have long known namely that infected wounds (wounds clinically sterile) may heal in a manner to which the term first intention may without injustice be applied.

What are the disadvantages of the Carrel Dakin method? I often hear it said that it is a difficult method requiring a special training of the surgeon that it requires a large amount of glass and rubber tubing bottles etc. that it is costly in dressings and that it calls for constant supervision or direction by the surgeon. There is truthfully no great validity

The Carrel Dakin method always stops short of perfection in asepais. The wound in my experience is never rendered sterile by this method. Organisms can be found in smears and developed in culture however long the treatment is continued in a large wound a fact which seems to me of great significance in relation to the question of the bactericidal value of Dakin's fluid. For when fluid in the same quantity as ever is applied and but few micro-organisms remain their ultimate annihilation appears to be impossible. Perfect sterility however we

in these objections. A special instruction of the surgeon is certainly necessary if he is to observe the ritual carefully and to understand what it means, but so it may be said is a special training necessary for the surgeon when any new technical procedure is introduced. The apparatus is cheap and is easily obtained and lasts with care for months. If nurses are carefully trained to do the dressings with punctilious care only that supervision is needed from the surgeon which he should give to every case. From a military point of view however it is a difficult method of practice for in our army we are compelled to evacuate a large proportion of cases to England retaining only those for whom movement has proved disastrous. The circumstances under which Carrel worked and under which he produced his splendid results could not conceivably be made applicable to a whole army. Some part of his success must truthfully be given to his opportunities both for receiving the case early and retaining them for long periods.

The chief disadvantage of the method is that if it is interrupted it fails lamentably. When cases have to be transferred from France to England it may for certain reasons be impossible to survey all the cases on board ship or on the train and infection then spreads and a rancid and rampant suppuration is present when the patient arrives at a base hospital in England. This is it is true an objection to a particular application of the method rather than to the method itself. But it is the reason, I think, that the procedure has never found a wide or general acceptance in the British Army though it has many warm advocates and many who practice it with a success equal even to that of Carrel or of Chutro. The chief successes obtained by this method are in the early cases, in those in which treatment can begin at intervals of not more than six or seven hours after the wound is made. But we are by degrees becoming less timorous in our efforts at primary closure in precisely this group and our results justify a wider acceptance and a more general adoption of this practice. In later cases the Carrel method is beyond question a therapeutic procedure of the first magnitude, but it then

requires unwearied care and inexhaustible patience if the best results are obtained.

*Rutherford Morrison's method.* This method is widely practiced in the base hospitals in England and by many surgeons is considered the most satisfactory of all. The technique is as follows: a wound say of the arm leading down to a compound comminuted fracture of the humerus is freely opened up after such preparation of the arm and of the surrounding parts as is made in all cases about to undergo operation. The skin that is to say is prepared with soap antiseptic washes (Morrison uses 1/30 carbolic acid lotion) and spirit. The wound may be enlarged in any direction in order to make sure that no recesses in it remain undiscovered. All granulation tissue is vigorously scraped away from the wound surfaces, bleeding points are secured, obviously dead and loose portions of bone or pieces of cloth or projectiles are removed. The wound is packed with dry gauze for a minute or two while towels about the wound are changed if necessary and while the surgeon replaces all instruments, gloves, etc. with those freshly sterilized. The dry gauze is removed, the wound sponged everywhere with gauze moistened with methylated spirit. On to the raw wound surface a thin layer of a preparation known as

Bipp (bismuth subnitrate or carbonate one part iodoform two parts paraffin in quantity sufficient to make a soft paste). With a gauze swab this paste is rubbed well into the wound which is then sutured from end to end without drainage. The arm is fixed on a splint and the wound left untouched for 10 days. At the end of this period it is usually found healed or nearly so, another dressing is applied and allowed to remain 10 days. No further dressing is needed. The absence of frequent dressings is an immense advantage and a comfort beyond words to an anxious overwrought patient.

Why does Morrison's method prove so successful? Is it the free mechanical cleansing of the wound that is of chief importance or is there some antiseptic or physiological virtue in the Bipp as a whole or in any of its constituent parts? It is almost certain that the perfect mechanical cleansing of the wound

lies the secret of the method. For I have treated wounds in exactly Morison's method and have omitted the paste and have seen the wounds heal as kindly as when it was used. If there is a virtue in the paste, in which of the ingredients does it lie? Probably in the paraffin which produces that anaerobic state in which healing can most rapidly take place. Mr. Morison at my suggestion tried his methods in two cases omitting the Bipp and he allows me to say that they healed as well as the others treated with the paste.

What disadvantages attach to the Bipp method? There have been several cases of bismuth poisoning and I have seen one of iodoform poisoning. In a certain number of the wounds, especially those which have been treated in France, the paste has been discharged in dribbles or in lumps after the whole wound has broken down. These faults are due to a wrongful application of the method. Perhaps less than the necessary care has been given to the thorough opening of the wound and certainly far too much of the paste has been introduced. One writer says the wound must be filled with Bipp; that instruction is of course the very opposite of the truth. If the paste is used at all only the thinnest smear is applied to the wound surfaces. The excellent and indubitable results of Morison's method have started once again the quest of the healing balm. All sorts of composite unguents and embalming materials have been tried. A very practiced surgeon, Captain Wilson Hey, has used with excellent effect a paste of which bone acid, paraffin, chalk and brilliant green are the ingredients. And good results have also followed the use of chloramine T paste and of acriflavine paste. Many control experiments by different observers using the several pastes or none are still necessary before we can say if any of them, or any parts of them, are essential to an equal degree of sound healing in the wounds.

*Flavine compounds.* During the last few months great interest has been aroused in the surgical world by the writings of Browning and other workers in the Bland Sutton Institute of Pathology in praise of flavine as an antiseptic for application to infected

wounds. Browning claims that flavine compounds (proflavine, acriflavine) and brilliant green exert a slowly progressive bactericidal action in concentrations which inhibit and finally kill bacteria, no harmful effect upon the tissues or upon phagocytosis is produced. It is said of the flavine compounds that their bactericidal potency is enhanced by the presence of serum; brilliant green on the other hand is reduced in activity by serum. The experiments of Browning are criticized by Fleming and Tanner and others. Fleming asserts that when many microbes are used in experiments similar to those of Browning the flavine must be in far greater strength than that given as the lethal concentration in order to effect sterilization; that in a concentration of 1:2000 flavine completely inhibits leucocytic emigration; that it has if tested over a period of 24 hours a greater destructive effect on leucocytes than on bacteria. Carrel has also spoken of the weak antiseptic action of flavine of its inefficiency under the conditions which really obtain in wounds of the destructive effect upon the granulations of a wound producing necrosis, arresting cicatrization and increasing the dimensions of the wound if used for any length of time. We have had in Leeds under the direction of Major Braithwaite and Lieutenant Gruner an experience of the flavine compounds extending over many weeks and embracing a great variety of cases and a trial of different methods of application has been made (Carrel technique, 12 hourly dressings, etc.). The naked-eye changes are an early reddening of the surface, a considerable diminution of the exudate, a disappearance of the fibrinous deposit, a firmer consistency of the granulations. If long-continued the flavine produces a more brilliant red tinge in the wound, a beefy look and apparently all processes of healing are held in complete abeyance.

The microscopic changes are first of all a rapid fall in the number of organisms per field which in several cases is apt to give place to a secondary rise about the fifth or sixth day in the absence of any necrosis of bone or retention of clothing or missiles. Then a change is found in the character of the cells, some of which undergo cytoplasmic

breakdown while others show decided phagocytic activity. Then this activity ceases to be manifest, and the bulk of the leucocytes undergo complete necrosis. As the wound improves in appearance so do the cells become few and necrotic. It is possible Grunre suggests that the flavine penetrates into the cell substance and alters its metabolism setting up necrobiosis along abnormal lines with a resultant flooding of the tissues with abnormal products of metabolism. These arrest the multiplication of the microbes. There may be an added inhibition of the outpouring of coagulable fluids, causing the wound surface to dry up after a few days. These changes appear to be more rapid with proflavine than with acriflavine. Many of the wounds treated with these compounds have been closed by secondary suture with results to all appearance identical with those which are found after treatment by the Carrel or Morrison methods.

Such is a brief statement of the present position with regard to the treatment of war wounds. It must never be forgotten that the time element is always an important factor and that the problem of dealing with an early contaminated wound is not identical with indeed may be marvelously different from that concerned with a late infected wound. The conditions in the early hours when the patients are at the casualty clearing stations in France are very different from those to be combated when the patient reaches a base hospital in England after the lapse of many days or many weeks. Finally in the English Army with the Channel and the long train journey interposed between the hospitals in France and those at home a new and very difficult set of circumstances must be taken into account.

But, wherever and whenever the patient is seen, the most urgent desire and the paramount concern of the surgeon is to secure closure of the wound. Whatever mode of dressing is adopted whatever procedure whether of physiological or of antiseptic principle is trusted it is the suture of the wound at the earliest opportune moment that must

be the goal of every effort. So far as our present knowledge will allow us to formulate conclusions the following deductions may usefully be drawn.

#### CONCLUSIONS

Perfect mechanical cleansing—that is, the excision of all contaminated infected or dead parts—the removal of all fragments of clothing (by far the most important of all causes of continuing infection in a wound) and of all projectiles is the supreme necessity in all cases.

In early cases this may allow of immediate closure of the wound which will be followed by healing in the great majority of cases, say in 80 per cent or perhaps even 90 per cent of those in which there is no loss of tissue.

In infected early cases the mechanical exposure and cleansing may be followed by a treatment directed to the removal of the remaining infection. Physiological and antiseptic methods have each their advocates. The aim of both is to permit of the earliest prudent secondary closure of the wound. In infected late cases a thorough mechanical exposure and cleansing of the wound and the parts around will allow of secondary closure forthwith if certain antiseptic pastes are used. Experience shows that similar results have followed upon this mechanical treatment of the wound without the introduction of antiseptics. A further trial in this class of cases may show that the natural defenses of the tissues are ample to deal with the infections then remaining.

It is the natural defensive powers of the body fluids and tissues, of serum and leucocytes that are the chief agents in finally subduing the bacterial infection in a wound. Sufficient reliance does not appear to be placed upon the stupendous power the body tissues possess for controlling infection.

Finally full emphasis must be laid on the paramount necessity for the complete immobility of wounded parts at all times and on all occasions. So will one of the most powerful agencies making for re-infection and auto-inoculation be kept in check.

II INJURIES TO THE PERIPHERAL NERVES AND THEIR TREATMENT<sup>1</sup>

## NATURE OF INJURIES

THE lesion of nerve trunks as the result of wounds inflicted in war may be of diverse forms.

I In the majority of cases the nerve trunk has not sustained a primary injury. It may be exposed in greater or less degree in a wound of the soft parts with or without fracture. If such wounds are gravely infected and suppuration occurs with perhaps necrosis of one or of many fragments of bone the process of healing may be long delayed and the cicatricial tissue which results will be of exceeding density. The nerve then may come to lie in the midst of a fibrous mass which, undergoing progressive contraction, presses more and more firmly upon the delicate and tender tissue of the nerve. The nerve trunk is strangled bereft of its due supply of blood, and becomes in consequence functionless. It is impossible before operation to decide in the severer cases whether such a nerve has or has not been completely divided.

II The nerve fibers may not have been directly or they may have been only very trivially implicated but the projectile may have passed so near the nerve trunk as to have opened its sheath. The nerve then becomes adherent to the track of the missile, and a mass of fibrous tissue is found firmly welded on to its lateral aspect. Or the projectile in this case a rifle or machine gun bullet may at that period of its flight when it has become steady have cleaved through the trunk of a nerve separating the fibers and severing few or none. Hemorrhage within the sheath occurs and a fibrous mass develops in the center of the nerve, causing it to assume a fusiform appearance. There is then a *central neuroma*.

III The nerve may have been partly severed say in half its diameter by a projectile or a fragment of bone. The gap in the nerve is soon filled up by fibrous tissue which extends widely upward and downward and away from the side of the nerve, so that a hard fibrous *lateral neuroma* is found.

IV The nerve may be completely severed. In such a case a gap of greater or less length is found between the divided ends. Bridging this interval there may be a connecting strand of fibrous tissue or a blurred mass of scar material in which both cut ends are lost. In some cases the nerve may appear hard and swollen, and as though its fibers were continuous but careful dissection will show that there is complete division.

When the nerve has been cut completely across the upper divided end is soon found to present a characteristic bulbous appearance. On section this is seen to consist partly of fibrous tissue and partly of nerve tissue. From the upper end of any divided nerve, the axis cylinders grow downward tirelessly each one searching out diligently but blindly the lower end to which it seeks to unite. When the quest fails in one direction and an uncongenial tissue is met, the axis cylinder turns in another direction searching there fruitlessly again and so twists itself in ceaseless contortion until a tumor a *terminal neuroma* is formed.

The fibrous mass often of extreme density which goes to the making of the bulbous end is probably the reply of tissues to the contact of exposed nerve fibers with them. The peripheral nerves are intruders among the other tissues of a limb reaching them by a process of invasion from without. The contact of these nerve fibers with any other tissue is prevented by their closure within a sheath whose function appears to be that of an insulator. The end organs of the sensory nerves may indeed be as W. Trotter suggests, a special mechanism for isolating the nerve fibers protecting them from actual contact with the tissues. Whenever the nervous system is injured by accident or design, as in the operations of trephining and laminectomy there is always a hasty and adequate attempt to isolate the parts again. There is an intolerance of the tissues for contact with nerve matter or conversely of these with other tissues.

Gosset says that the axis cylinder is very

<sup>1</sup> In the preparation of this paper I have received valuable help from my colleagues on the staff of the Second Northern General Hospital, Leeds Capt. Barrow, Capt. Dew, Capt. Richardson, and D. Cuthbert Morton.



unintelligent. I am not sure that its search for the distal end is stupid because it is unsuccessful. The search is zealous enough, but the axis cylinder shrinks from ignoble contact with a baser tissue and turns aside to seek elsewhere. The lower severed end becomes thickly covered with a fibrous cap which forms a barrier impenetrable by the axis cylinders seeking so earnestly to find their way along the distal nerve.

1. The relative frequency of affected nerves has in our experience been as follows:

Nerve	Per Cent
Musculospiral	5
Ulna	4
Median	14
Scaphic	1
Internal popliteal	
Internal popliteal	
Upper portion of the brachial plexus	4
Lower portion of the brachial plexus (cords)	7
Anterior crural	

This corresponds fairly accurately with the experience recorded by Gosset and by Tinel.

2. *Diagnosis.* The following points in the clinical histories are investigated: date of injury, nature of projectile, position of patient at moment of injury, immediate effects after history (including history of operations performed).

Physical examination consists in—

A. Inspection of the limb to note (1) attitude, contractures (claw hand etc.), (2) position of wounds and scars.

B. Testing of the efferent impulses. (1) Motor weakness for paralysis, each muscle and each muscle group being tested separately. (2) Trophic and vasomotor disturbances: Non-shedding of epidermis, glossy skin, ulcers, changes in nails etc. (3) Changes in deep tissues e.g. muscular atrophy, fibrillation, bone decalcification, etc.

C. Testing of the afferent impulses. (1) Pain, its character, distribution, relation to hot and cold applications or weather. (2) Loss of cutaneous sensibility, tested by standardized stimuli of special instruments so that the results are strictly comparable. Light touch. Localization of spot touched. Tactile discrimination (pressure, texture etc.). Stereognostic sense (size and shape of three dimensions). Appreciation of compass points

applied simultaneously. Thermal stimuli (hot and cold test tubes). Painful stimuli (pinprick controlled by standardized spring). Roughness (Graham Brown aesthesiometer). (3) Deep sensibility—pressure pain, vibration sense in bones, joint and muscle sense, etc.

D. In the electrodiagnosis the reactions to the interrupted current are tested by shocks from an induction coil, the electrode being placed upon the motor point of each muscle in turn. The current from a secondary coil is always used.

A positive reaction to faradism is regarded as a contra-indication to operation, but failure to respond gives no definite information, for voluntary movement may return, after nerve injury, before the faradic response.

The muscles are next investigated by a constant current. Polar changes have been found to be of minor value; they may vary with the local curvatory changes following massage etc. The character of the contraction is of much more importance. A brisk twitch indicates the probable presence of some conducting nerve fibers in the muscle tested, while a slow, vermicular response is usually associated with a complete interruption of nerve fibers.

The nerve muscle is next examined by means of a condenser discharge. The method depends upon the fact that a condenser discharge through a constant resistance gives a current which varies in duration according to the capacity of the condenser used.

The more severe the damage to the nerve the greater will be the capacity of the condenser required to excite it. Or in other words, the longer the duration of the current the more chance is there of obtaining a response in such a nerve muscle.

The whole advantage of the condenser method is that a definite measurement of current, or condenser used, may be noted and future progress may be accurately followed.

The condenser method is chiefly used in cases where operation is deferred because some function is found to be present in a given injured nerve. (The work done recently by E. D. Adrian and others shows that the condenser is disappointing in practice, but it,

nevertheless gives useful information in recording progress)

Complete absence both of faradic and galvanic response is an indication for early operation. The cases which require careful and repeated examinations are those where there is pressure on the nerve trunk by a contracting scar. In some nerve trunks there is little damage to some of the fibers with total loss in others. Operation must not be deferred too long in these cases because the fibers with complete reaction of degeneration may never recover on account of a dense scar tissue formation at the site of injury. In other words, the presence of a degree of voluntary power in some individual muscles of a group supplied by a damaged nerve is no sure criterion that the paralyzed muscles will recover without operation.

It is most important that nerve injuries should be re-examined at frequent intervals and carefully detailed records of motor power, sensory changes and electrical reactions kept. In this way treatment may be modified according to progress.

In operations upon nerves where a diagnosis of total loss in some fibers only has been made it is our practice to test the exposed nerve both above and below the site of injury at the time of operation. For this examination special sterilizable electrodes and long connecting cords which can be boiled are used. The nerve is gently lifted upon two small glass hooks and a very weak faradic current employed.

The most accurate anatomical arrangement of fibers may be noted by this means and the knowledge used to secure perfect adaptation in nerve suture. The diagnosis is often completed during a period in which massage, baths, and electrical treatment are employed to improve the local circulation and splint treatment adopted to relax affected muscle groups and to overcome contractures. The distinction between anatomical and physiological division is not made before operation.

The main difficulties encountered in arriving at an exact diagnosis are in cases where there are wasting and stiffness from disuse, circulatory disturbances, contractures, destruction or adhesion of muscle and tendon.

*Operation is decided upon* in the following circumstances: (1) in cases of complete division, (2) in cases of incomplete division where progress is arrested, (3) where there is severe neuralgic pain 'causalgia'.

*Operation is deferred* (1) for one month after the closure of the wound where soft parts only are injured, (2) for two or three months after complete closure of the wound where bone has been involved, and (3) definitely so long as progressive signs of recovery in nerve functions continue.

The suture of the nerve may have to be delayed until unsatisfactory joint conditions are improved. Contractures of the knee for example should be corrected before the sciatic nerve is sutured; otherwise the nerve would be in danger of rupture if the deformity were subsequently rectified. In other cases the nerve may be sutured and the joint dealt with at the same period and subsequently. It is of the first importance to start active measures to prevent or remove stiffness and deformity in the parts supplied by a wounded nerve. This can often be done for many weeks before it is possible to repair the nerve. It is not sufficiently realized that a nerve to be of use after suture must act upon live and supple tissue. Joints and muscles must be kept ready for the nerve impulse which some day will come to them again.

When the diagnosis of a nerve lesion requiring operation has been made the earliest prudent occasion must be chosen for operation. In both the French and British armies nowadays the suture of a divided nerve is performed in those most advanced operating centers where the first deliberate toilet of the wound is possible. It is realized of course that very often a complete union between the severed ends cannot result, but, even if the operation prove eventually to be a complete failure, the subsequent operative procedures are certainly easier and it is a satisfactory thought that a chance has been given for healing to take place.

In the great majority of nerve lesions dealt with up to recent times the wound inflicted by the projectile has suppurred. We have learned by bitter experience in this war what this means. It means that the bacterial flora

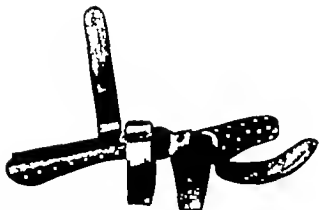
in such a wound are numerous and, potentially at least, of great malignancy. It means that even a simple operation upon a wound which still discharges pus may arouse a flaming infection and be a cause of tetanus or gas gangrene. Mere passive movement of a joint grown stiff by inactivity may bring about an attack of tetanus even though the adjacent wound has healed. In many cases an injury to bone may have been inflicted at the same moment as the division of the nerve; this is, of course, frequently the case when the musculospiral nerve is implicated. Many loose pieces of bone may remain as sequestra in the wound and may need removal or may escape spontaneously from time to time. In all such cases, operation upon the nerve must be deferred until the wound has been soundly healed for some weeks; no rule is more binding upon the surgeon than that. During this period which may be protracted the most diligent attention must be given to the limb, especially to those parts, muscles and joints, distal to the injury. The paralyzed muscles must be kept in a position of relaxation. This may be easy, as in those cases where the musculospiral nerve is divided; it is often difficult as in cases of injury to the median nerve; it is sometimes impossible as in dual or triple lesions of nerve trunks. But difficult or easy, the best possible must be done for the final functional result in respect of quality and of rapidity depends in no small degree upon the early care of the parts deprived of their nerve supply.

Special and unremitting attention is given to the joints which must always be kept supple. It is remarkable how quickly the fingers, for example, become so stiff that forced movement is an agony. Every day many times a day all the paralyzed parts must be freely moved to their full range and the patient must be instructed to attend to this matter unceasingly. The most perfect nerve healing is robbed of its value if through long disuse the muscles whose innervation is restored, have lost their power to act, and if the joints are so firmly ankylosed that even passive movement cannot bend them fully. The value of these preliminary and preparatory measures cannot be overestimated.

When the operation actually takes place it is important to observe certain essentials to success. There must be the most perfect and scrupulous asepsis and the most gentle handling. The finger should never be placed in the wound. All dissection should be carried out deftly and neatly; the most diligent care must be taken never to bruise the nerve by seizing it however gently in forceps. The nerve must never be twisted or torn or stretched, or unduly separated from its bed. Other structures must be dissected from the nerve; the nerve must not be dissected from them. The nerve must not be stripped bare for too long a distance otherwise it will be devascularized, and recuperative processes will be slow or absent. The wound, as a whole and the nerve in particular must not be allowed to dry or to be chilled. The most dainty and precise movements are necessary throughout and every bleeding point must be thoroughly secured. There are, of course, the observances that go to make up the ritual of every well-trained surgeon; their strict acceptance is more necessary here than in almost any other operation, if the most rapid and the most flawless recovery is to be made certain.

As a rule a tourniquet is undesirable, for two reasons: it is possible to harm the nerve, or other nerves in the limb; if the rubber band is applied too tightly and for the long period sometimes necessary in this procedure and when the operation is complete and the tourniquet removed there will probably be an escape of blood into the wound a thing in these cases most undesirable. In these wounds not infrequently there is a good deal of young fibrous tissue from which free coagulation may occur in the period of hyperæmia which follows removal of a tourniquet.

The incision is designed to fall on the skin at some distance from the original wound; if possible very often a flap will occur from the making of a curved incision. The planning of the incision gives scope for one's knowledge of anatomy; it is so arranged that no small nerves are wounded. Major Jamieson has shown that when the median nerve is injured in the forearm it may sometimes be more thoroughly and successfully dealt with from the outer instead of from the inner side of the



Splint designed by Dr. Cuthbert Morton for application to cases of musculospiral palsy in order to secure extension of wrist and grip position of the hand.

flexor carpi radialis. So too when the musculospiral nerve has been injured high up on the outer side of the forearm Dr. Cuthbert Morton suggests that instead of cutting through the outer head of the triceps it should be reflected completely from the humerus. Not only does this cause less damage to the muscle tissue but it also exposes the nerve and its branches as well as the profunda artery to a very high level without undue risk.

The nerve trunk is sought above and below the point of severance and is traced downward and upward to the gap. Swift neat little cuts with a very sharp scalpel damage the tissue to the smallest possible degree. The surgeon must avoid contact of his fingers with the wound; it is clumsy and unartistic to prod about among muscles in the hope of feeling the nerve. It is his business to know

before he begins these operations exactly where the nerve lies and be should always be able to cut directly down on it. When the injured part of the nerve is exposed it is usual to find a bridge of fibrous tissue between the ends, the proximal end being often very turgid and bulbous. If the gap between the refreshed ends of the nerve is likely to be wide now is the time for stretching the nerve so as to lessen the interval as much as possible. This is done with infinite gentleness and care by seizing the fibrous band between the ends and drawing steadily upward and downward, always remembering to make the pull in the line of the nerve trunk and to avoid twisting. The fibrous band is now split longitudinally and then its ends are divided above in one direction below in the other so that to each cut end of nerve a fibrous tag is attached by means of which the nerve ends can be drawn together. Progressive transverse cuts are now made into the nerve ends until on the



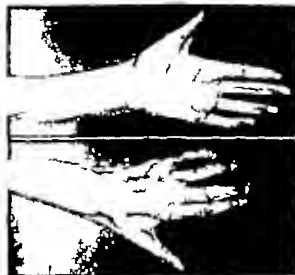
Case of division of nerve cord of brachial plexus to show typical position of the hand.



Sciatic canalgia. Paralysis of both groups. Nerve operated on and symp. ms. (In this case) were relieved at once.



Case of division of median and ulnar nerves. The photograph by the left is of the hand and the right is of the ulnar nerve.



Case of division of median and ulnar nerves, same case preceding photograph showing the rapid tropic response after operation.

cross section nothing but nerve fibers are seen. Every tiniest particle of fibrous tissue must be removed or the operation will fail. The axon cylinders coming from above must have free entry into the nerve bed with other wise in their downwardplex I present they will lose their way and restoration of the nerve function will not take place. When the nerve ends are fully prepared they are brought into apposition with the greatest care. A series of very fine catgut sutures holding only the nerve sheath are inserted at intervals round the circumference of the nerve. A suture is never passed through the substance of the nerve itself. In uniting the nerve ends it is of the first importance to avoid axial rotation. We know now that there is differentiation of function within each nerve and it is therefore critically necessary to unite corresponding

bundles of fibers. A nerve does not act as a whole but consists of a multitude of strands each with its proper and restricted function. Unless nerve bundles which were originally continuous are brought accurately together by suture the nerve is compelled to rearrange the functions of its several parts. This it can and no doubt frequently has to do. An examination of many cases shows however that a perfect and flawless recovery after a nerve suture is unusual and it is at least a tenable belief that this inadequacy or delay in recovery is due to a want of recognition by the surgeon of all that is needed in the technical part of the operation. My colleagues on the staff of the Second Northern General Hospital in Leeds are obtaining results which in rapidity and completeness would have been thought impossible before the war.

There is rarely any difficulty in obtaining accuracy of apposition without tension. If however the nerve ends cannot readily be brought together various procedures may be adopted to shorten the course of the nerve. The nerve may be dislocated from its bed and laid in a new and shorter line. The ulnar nerve for example may be brought to the front of the inner condyle. Or flexion of the limb may be enough to allow of easy approximation. In the case of the median nerve divided

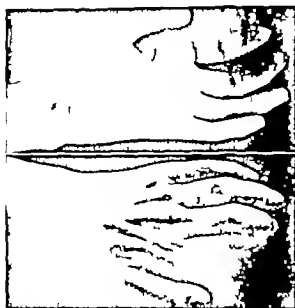


Case wounded by bullet November 2 1914. Inner cord completely divided with artery. Nerve suture December 8 1914. May 5 1915 Function almost completely restored. June 16 1915 Function still improving. August 30 1915 Patient returned to duty. The only abnormal remainder was some hyperalgesia in palm. All muscles perfect.

low in the forearm flexion of the wrist will give an inch or more additional reach. In other cases the limb may be shortened by removing an inch or two of bone. It is desirable to avoid a subcutaneous course in all transferences to new positions. The nerve after suture should be brought to lie in a bed of healthy tissue. It must be placed between muscles and away from all contact with new connective tissue which will adhere to it, and hinder its union or cripple its subsequent action.

It has been the fashion with many surgeons to surround the sutured nerve with some material supposed to have protective virtues. A piece of a vein, the saphenous for example, is threaded over the upper cut end of the nerve before suture, and after these ends are approximated the vein is drawn downward and made to surround the line of suture. In other cases a piece of fat dissected from near the wound or from another part, is wrapped round the nerve, fat being supposed to be capable of insulating the nerve in its new position, or a layer of fascia may be used or a piece of Cargile membrane. The value of all such methods is open to serious question. It is certain that they are sometimes harmful; it is doubtful if they ever help. They prevent access of blood to the nerve by new chan-

nels they cause adhesions and compression of the nerve and at times they are discharged from the wound almost unaltered. It is better to avoid such membranes and to be content with insuring that the nerve is laid along a path of uninjured tissues. Where end to end suture is impossible a variety of other procedures may be attempted. A nerve graft taken from a neighboring cutaneous nerve from the radial, the internal cutaneous of the thigh, or an intercostal nerve may be used. Experience on the human subject has not yet enabled me to determine the value of this procedure. In experimental work it answers well, but I have rarely if ever seen a result which could be claimed as satisfactory. Colonel Mayo Robson<sup>1</sup> has had one of the very few successful cases. Nerve anastomosis has been tried in a number of cases. The divided ends of a nerve are implanted into the side of a near lying nerve, the ulnar into the median for example. This has been done both with and without, section of the nerve fibers of the intact nerve. All such procedures are worthless and cannot be too strongly condemned. I have never seen any good come of them, indeed nothing but harm could conceivably result from section of a healthy nerve. And if it is allowed



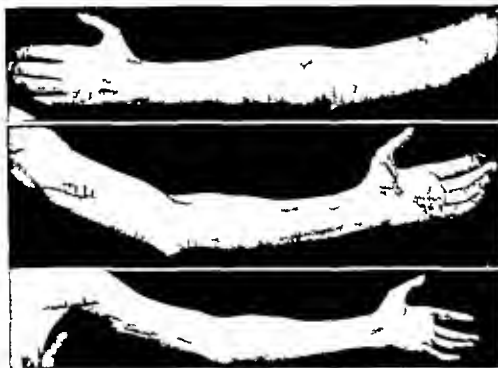
(12) Ipsilateral of both median and ulnar nerves due to wound caused by rifle bullet

as it must be that a nerve consists of many separate strands each with its own special and exclusive function it is certain that permanent damage is inflicted by this method. There is no justification for this procedure nowadays and it should be cast out among forgotten things. Lengthening of the nerve by turning down a strand from the upper divided end or the bridging of the gap by strands of catgut are methods with nothing whatever to recommend and everything to discredit them.

Happily the resources of surgery are not at an end in all cases where union of divided nerves is impossible. Tendon transplantation especially in the case of the musculospiral nerve and the posterior interosseous gives results which in point of function are almost as good as those which come from nerve suture and in point of time are much quicker. It is chiefly in the musculospiral nerve that large gaps are found a piece of the nerve having been blown completely away. In such cases tendon transplantation gives excellent and speedy results. When the posterior interosseous nerve is wounded it is not worth while attempting to suture the nerve. The results in such cases are slow and not always perfect.

In those cases where the nerve is partly divided strands of intact fibers still remaining the severed fibers are united in the same careful way and the normal strand of the nerve bent upon itself so as to allow easy approximation of the cut portions of the nerve. In perhaps the majority of operations upon nerves there is no division of fibers but a length of the nerve is imbedded in dense fibrous tissue. These cases give most excellent results. The fibrous tissue which so intimately surrounds the nerve is dissected away little by little. The nerve when first freed is seen to be white and shrunken but within a few minutes it expands and takes on its normal color. I had several cases of this kind in the Boer War and the results at this long interval are perfect. It is in these cases that advantage may sometimes be taken of the method of fat transplantation or of nerve dislocation.

*After-treatment (1) Postural.* In those cases where flexion of a joint has been necessary to allow approximation of the cut ends of nerves, the position is maintained for a period of six weeks. By this time union of the severed ends is probably well advanced. Extension by slow and most cautious degrees is then begun. If the knee has been flexed to allow the sciatic nerve to be united the patient can walk with a boot and leg irons keeping the position unaltered for say two months. Whenever possible a splint is applied which produces a relaxation position. In the case of the median and ulnar this is difficult but is best secured by molding a ball splint to the hand of the patient. Every such splint must be made for the individual. In the case of the musculospiral it is very simple. The cock up splint designed by Colonel Sir Robert Jones is excellent if the lesion of the nerve is below the branch to the supinator. It maintains hyperextension of the wrist and reaching only to the heads of the metacarpal bone it allows a forward bend of the metacarpophalangeal articulations. The thumb lies forward and a little inward so that the position of the whole hand is very much that assumed when a bottle is grasped. If the lesion is above the nerve to the supinator brevis it is essential that this muscle also



CASE wounded by bullet, August 8, 1916, examined and photographed February 9, 1917, operated upon February 12, 1917. Ulnar nerve involved in dense scar (functionless) freed. Median nerve and internal cutaneous completely divided and sutured. Two incisions shown. Through the upper the projectile passed, through the lower the nerve operations were performed. Top picture taken February 2, 1917. Second photograph (at bottom) taken June 6, 1917. Some sensory return in addition to recovery from trophic changes. Flexion at wrist present. August 28, 1917. Almost complete recovery except in hand muscles.

should be relaxed. For this purpose Dr. Cuthbert Morton has devised a splint which retains the forearm and hand in supination while the wrist is fully extended, the fingers being at the same time kept in the bottle grasping position.

Similarly in cases of injury to the external popliteal nerve, relaxation of the corresponding muscles may be secured by the boot which has been introduced by Dr. Cuthbert Morton in order to allow the patient to walk about with the foot in permanent dorsiflexion.

*Massage and electrical treatment.* These measures are restarted about two weeks after operation with all due precautions and safeguards. If a splint has been applied to secure the relaxation position, it must not be removed. Indeed, not for one moment at any time must paralyzed muscles be stretched. An overstretching of a few minutes may call for diligent treatment of many weeks before the harm is undone. If a splint needs removal for purposes of cleanliness, the patient

must be instructed beforehand to keep the limb in the exact position required. In the case of musculospiral palsies, the hand drops into the correct position if the flexor surface of the forearm is upward.

*Results.* Our records are as yet necessarily incomplete. Recovery in the case of the musculospiral has begun within 9 weeks; in the case of the ulnar within 3½ months; in the case of the median in 4 to 5 months. In one case of division of the inner cord of the brachial plexus, recovery in all anasthetic areas and a degree of recovery in all muscles occurred within 5 months. Recovery in the case of the sciatic nerve is slower. Something depends on it is sometimes said upon the length of time elapsing between division of the nerve and its suture. My colleague, Captain Richardson, has however united the ends of an ulnar nerve cut across 15 years before and signs of returning function were seen in about four months. The duration of the disability is therefore no bar to successful nerve repair.



The function returns usually in the following order: (1) trophic and vasomotor function (2) localization (3) tactile discrimination and localization (4) motor power (5) thermal sensitivity.

Perfect restoration of function has been most nearly approached in the case of the musculospiral nerve. In other nerves with more complex distribution perfect recovery will depend upon a recognition of the functional localizations within the nerve trunk. In addition to the most scrupulous observance of all these technical details with which there will always be something less than perfection.

In the diagnosis and treatment of an organic lesion of a nerve it should never be forgotten that there may be superadded a functional disability. It is a fallacy at every stage to get rid of the functional disorder properly to appreciate the organic. This is particularly important when the organic lesion is well on the way to recovery. Thus in a recovering lesion of the inner cord of the brachial plexus it may be impossible for the fingers to be flexed until reeducation has trained the laggard muscles into obeying order from headquarters.

#### SUMMARY

The following summary may be given of our experience up to the present time:

1. The earliest examination should be made of all wounds in which laceration of a nerve trunk is probable. If at the casualty clearing station such a lesion is found end to end suture should be attempted forthwith. This is more likely to be possible in cases where primary suture of the wound after excision is found practicable.

If secondary suture of the wound, after the Carrel-Dakin method has been practiced, is to be undertaken the union of divided nerves should be secured at the same time.

3. If these methods have been attempted and have failed they do not prejudice the later union of the nerve. On the contrary they probably insure that an easier and more satisfactory operation can then be practiced.

4. Throughout the whole period before late nerve suture is attempted the strictest attention must be paid to the relaxation and nutrition of all paralyzed muscles to the maintenance of suppleness in all joints moved by these muscles and to the preservation of the integrity of the skin.

5. Operation upon nerve trunks demand the most scrupulous observance of the ritual of asepsis. There must be the greatest gentleness in manipulation the nerve must not be injured by instruments or by the surgeon's finger; it must not be separated from its sheath or disturbed overmuch from its bed; it must not be chilled or allowed to dry. All sutures must be of fine catgut and introduced with most punctilious accuracy. Axial rotation of the nerve must be avoided. The cut ends of the nerve before approximation must show clearly the fibers of which the trunk consists.

6. Nerve grafting is of little or no value; nerve anastomosis is to be sharply condemned; the turning down of flaps from the nerve to bridge a wide gap is useless.

7. Tendon transplantation is of great value in cases where nerve suture is impossible or where suture has given a result not entirely satisfactory.

III GUNSHOT WOUNDS OF THE LUNGS AND PLEURA<sup>1</sup>

THE mortality of chest wounds in all zones of the army is extremely difficult to ascertain with anything approaching to accuracy. Pierre Duval whose work on the surgery of the lungs during this war has been characterized by originality, insight, prudent courage, and great technical success, has gathered together the records from many parts of the French Army. Of a total of 3,455 cases there were 688 deaths, roughly a mortality of 20 per cent. But the mortality differs as may well be imagined at various parts of the line of communications. At the aid posts it is terrible, not less it is asserted than 25 to 30 per cent. At the ambulance, surgical automobile, or casualty clearing stations, the mortality is about 18 to 20 per cent. In the base hospitals the death rate is about 10 per cent. There is it will be seen a progressive diminution in mortality from the front to the base. Pierre Duval scrutinized these figures in the following remarkable way:

At the aid posts, where the mortality is 25 per cent, there will remain alive of 100 patients 75. At the ambulance of these 75, 20 per cent will die and there will remain 60 patients. At the base of these 60, 10 per cent will die so that finally 54 cases will survive.

Two series of cases falling under individual observation may be quoted. Gregoire records a total of 404 cases of chest wounds, pure and simple, i.e. without other injury, with 47 deaths, a death rate of 11.7 per cent. Of these 57 patients were operated upon for empyema, with resection of the rib and drainage; 26 died, a mortality of 45 per cent.

DePage, at his well-known hospital at La Panne, which combines the functions of field ambulance, casualty clearing station, and base hospital, receiving patients a few hours after injury and retaining them as long as is necessary, records 320 cases of pure chest injury with 59 deaths, that is 18.4 per cent. Within the first 24 hours 9.4 per cent of cases died, chiefly from hæmorrhage. In the later stages 10 per cent of the survivors died, chiefly from sepsis.

Elliott<sup>2</sup> estimates the mortality of chest wounds in the British Army in France at the field ambulances and casualty clearing stations at from 20 to 25 per cent, of which 10 to 15 per cent are the early result of shock and hæmorrhage, while 10 per cent die of sepsis. The mortality on the lines of communication is about 5 per cent; all these deaths are from sepsis. The mortality of cases reaching England is small.

All observers are agreed that there is a difference in the mortality according to the projectile inflicting the injury. If a rifle bullet causes the wound, the condition resulting is either very serious, if a large vessel is struck, or very benign, if the lung tissue is traversed without serious vascular injury. Wounds with high explosive shell, the fragment causing the wound being irregular and jagged, when pieces of clothing or of skin are driven deeply in, are always serious by reason of the infection that is so prone to follow.

Rouvois, in 102 cases, found the following: In 60 cases where the projectile was retained, there were 27 deaths; in 26 of these the wound was caused by shell, in one case by rifle bullet. In 42 cases of perforating wounds, there were 10 deaths; in 9 of these the wound was caused by shell and one by rifle bullet. These figures are a truly remarkable comment upon the influence of the projectile in determining the mortality.

Death occurs chiefly from two causes, from hæmorrhage or from sepsis. Hæmorrhage is fatal early, generally within the first 24 or 48 hours. Sepsis proves fatal at a later stage, generally from the seventh day onward. The most fatal cases are those where there is a gaping wound of the chest so that the lung is freely exposed. The mortality in cases where the chest wall is closed behind the projectile is rather less than one half of that which results when there is an open wound. Captain H. Henry, in 100 postmortem examinations made upon patients with chest wounds who reached a base hospital in France, found that the great majority of deaths were

due to septi infection. Only 4 patients died from hemorrhage and in 3 of these the hemorrhage was secondary in character and was induced by sepsis.

#### PATHOLOGICAL ANATOMY

The injuries inflicted by a projectile entering the chest may be considered in their effect upon (a) the chest wall (b) the injured lung (c) the opposite lung.

*The chest wall.* The damage done to the chest wall may be of the most diverse forms. There may be a clean penetration of the thorax from front to back, the projectile in this case a rifle bullet cleaving a way through all the tissues it meets here precisely as it does when the thigh or the seat part anywhere are pierced. In many of these cases however and in a still larger number when there is a shell wound there is a fracture of one or more of the ribs or of the scapula. Fragment of bone tiny spicules or larger pieces are carried into the chest and at a later operation may be recognized and removed either from the lung itself or from the pleural cavity especially in the cul de sac above the diaphragm. The same result follows this scattering of the bone into the lung as occurs when there is a compound fracture of the long bones in the limbs. Each bony sequestrum becomes itself a projectile driven with force into the tissues and carrying with it a capacity for infection and inflicting a grave injury upon all the part through which it tears its way. The conditions so produced are serious and long continued.

In several cases a part of the chest wall may be destroyed being driven inward by a massive piece of shell casing or being swept away by a glancing blow. Few cases reach a base hospital in France and still fewer of course in England where any large portion of the parietes is lost. Such cases die in advanced stages up the line from shock or from hemorrhage. The few that I have seen at base hospitals were all heavily infected and suffered much distress. Their condition is a powerful argument in favor of the early closure of all parietal wounds wherever possible.

*The injured lung.* The effects produced in the lung are strictly comparable to those pro-

duced in other parts of the body by the various forms of projectile. The points of entrance and of exit in the case of perforating wounds bear all the appearances of those seen in the soft tissues of the thigh. The entrance wound is small even punctate, the orifice of exit is larger, more irregular and bears signs of greater injury and of a tendency to protrusion of wounded parts. Along the track of the missile there are the same evidences of diffused injury. The parts around are bruised and lacerated, there is a hemorrhagic pulmonary infiltration of varying but often wide extent. The part of the lung giving onto the track is contused or dead, and such tissue offers here as elsewhere the most favorable opportunities for bacterial invasion and growth. Postmortem examinations of wounded lungs generally show that the track of the projectile whatever it may have been is rectilinear. There are no fissures or rifts radiating from the main track nor any hidden pockets shut off from the central channel. Several tracks may be found in close approximation when many fragments of metal have entered. The bronchi of large or medium size seem to escape injury in the majority of cases. In the path of the projectile blood is extravasated in the earliest hours in later stages pus may be found.

The injury to the damaged lung is not, however, confined to the path of the bullet, and the parts immediately adjacent. The distant portions of the lung or the pleura bear traces of lesions due to the force with which the parts are struck. There may be hemorrhages by *contrecoup* in the upper lobe if the lower is wounded or in the lower if the upper is injured or in both if the projectile has passed near the base of the lung. These, as Duval has shown may be recognized at once by the opacity seen on the radiograph and I have found in later operations many recent adhesions of the pleura over parts that could by no possibility have met with a direct assault. These conditions are of the same order as those described in an early fatal case by Latarget. He found a massive congestion of the whole lung a sort of diffuse hemorrhagic infiltration, in a case in which a bullet wound was inflicted at close range.

Such meager postmortem experience as exists confirms the impression that is derived from the clinical examination of operated cases that wounds of the lung heal rapidly and kindly.

*The opposite lung* It is a new experience gained during this war that the opposite lung suffers damage also. Such lesions are frequent in the severer cases probably constant. They consist in small or large hæmorrhages beneath the pleura or in the substance of the lung. These may be followed by filamentous or by firm adhesions between the visceral and parietal pleura. In a late stage the lung may present all the evidences of a bronchopneumonia, at one point, or in many. The increased activity imposed upon the lung by the restricted function of that which has been wounded no doubt renders it an easy prey to any malady. The presence of an infected mucus in the trachea may lead to the inhalation of purulent or septic material into the uninjured lung. These conditions often improve very rapidly when the injured side is treated by aspiration of a large hæmothorax or free drainage of an empyema.

*Hæmorrhage* When a missile enters or traverses the chest, any of the vessels contained therein may be lacerated. If the larger vessels in the mediastinal cavities or in the root of the lung are divided the loss of blood is so copious and rapid that death results at once and the patient does not reach even an advanced aid post.

In the cases not immediately fatal the blood comes in the very great majority of cases from the lung tissue. Henry and Elliott as a result of careful investigation of the thoracic walls and the lung in 78 post-mortem examinations made on the subject of hæmothorax came to the conclusion that the bleeding had been of pulmonary origin in the great majority of cases.

Apart from the cases dying instantly from hæmorrhage the deaths in the first 48 hours are all due to loss of blood from lung tissue. Both in the French and the English armies precocious operative measures are being adopted in such cases with a degree of success that encourages a wide adoption of this practice. If death does not occur speedily from

hæmorrhage a recurrence of bleeding is not often seen. Patients rarely die from hæmoptysis and secondary hæmoptysis is extremely infrequent. The occurrence of hæmorrhage through the wounds of entry or of exit is probably responsible for the erroneous belief that it is from the chest wall from the intercostal vessels that the blood is lost.

Dolbey records one very remarkable case of gross hæmorrhage resulting from a wound of the axillary vein. The chest filled with blood from the torn vessel but after two large aspirations the wound in the vein healed. There was also an aneurism of the axillary artery which was successfully treated by ligation of the subclavian artery.

*Hæmothorax* When blood escapes into the pleural cavity what happens to it? According to Elliott and Henry it appears probable that clotting always takes place—and very early—through the action on the blood of the ferment liberated at the surface of the wounded tissues. The clot may be (a) complete and massive forming a soft and persistent clot, (b) massive but with an early and fairly extensive separation of the yellow serum from the clot, (c) interfered with by the churning movements of respiration (and of the heart?) so that the fibrin is whipped out in layers which cover the pleural surfaces while the serum retains most of the red corpuscles in suspension.

The amount of blood extravasated into the pleural cavity varies very much, from a few ounces up to 4 or even 5 pints. The escape of blood is hindered and at last arrested by collapse of the lung and by the pressure exerted by the blood which has already flowed into the pleural cavity. The response of the pleura to the contact of blood is expressed in an inflammatory reaction which also helps in some degree to seal the leaking orifice though it also increases the mass of fluid lying in the chest. The admixture of fluid effused from the pleura accounts for the fact that in many cases the condition of the combined fluids does not conform with that seen when only blood is extravasated.

Hæmothorax in itself though disabling enough and productive of such general effects as the loss of a large quantity of blood neces-

sarily entails is not dangerous to life apart from infection. The bacteria chiefly responsible for this hazardous complication are according to Duval

A Aerobic

- 1 Derived from the respiratory tract
  - Innococcus*
  - Staphylococcus*
  - Bacillus tetragenus*
  - Bacillus of Pfeiffer*
- 2 Derived from the wound
  - Streptococcus*
  - Bacillus coli*

B Anaerobic

- Bacillus of Welch*
- Bacillus sporogenes*

The most common association is of the *bacillus coli* with the gas gangrene bacillus.

The frequency of infection may be gauged from the figures given by Captain Henry. Out of 500 specimens of fluid obtained by tapping in the ordinary routine of work 195 were found to be infected and of these 87 were infected by aerobic organisms. These may be distributed from the first throughout the bulk of fluid or they may be retained in the fibrinous mass at the bottom of the pleura for a longer or shorter period, being disseminated at last through the supernatant fluids as a result of the respiratory movements. This accounts for the fact recorded by Elliott and Henry that the first puncture made for diagnostic purposes was found to be negative in 50 per cent. of pure infections by anaerobic bacilli. The syringe introduced into the upper fluid part of the hæmothorax may discover no organisms whereas one made lower down into the more solid fibrinous clot may give positive results. The infection may be derived from the projectile or clothing carried into the wound at the moment of the infliction or may be derived at a later stage from the focus in the lung or from the suppurating external wound. Pierre Duval in the Somme battles had charge of 193 cases of gunshot wound of the chest. Of these 49 were due to bullet wounds none of them had an infected hæmothorax there were 33 perforating wounds from shell fragments and among these were 6 of infected hæmothorax 18 per cent. there were 111 penetrating

wounds among which were 28 of infected hæmothorax 24 per cent.

### TREATMENT

Upon one point all those who have been responsible for the treatment of a patient with a chest wound are in complete and confident agreement. The earliest and the most perfect immobilization is necessary. Movements of all kinds are to be avoided and therefore retention of the wounded man at the casualty clearing station for many days is a paramount necessity. The fact that in the first two days the deaths are due chiefly to hæmorrhage and in later stages to sepsis must direct the timely and appropriate treatment. Early operations for the purpose of arresting hæmorrhage from the lung tissue have been tried only in certain hospitals in either the French or the British zones but so far as the results of the work have gone they appear to justify a continuance and indeed a general adoption of the principle of early direct treatment of the wound. It is I think largely owing to the advocacy and to the successful practice of Pierre Duval that an earlier surgical attack is now considered necessary upon the greater kind of lung case.

Immediate intervention according to Duval should comprise

- 1 Closure of the chest wall in cases of open thorax
  - 2 Thoracotomy with suture or plugging of the lung in case of grave hæmorrhage or of threatening asphyxia
  - 3 Treatment of progressive surgical emphysema
- 1 Closure of the chest wall an operation practiced by Larrey in the Napoleonic wars, has as its aims the suture of the muscles and skin in order to avoid traumatopnoea, pneumothorax and a continuing infection of the pleura from the suppurating external wound. The principles are those guiding the surgeon in all similar wounds elsewhere the results in the saving of life and suffering are incalculable. The gravity of the cases of open thorax can hardly be exaggerated. When a part of the chest wall has been torn away the lung often bruised or lacerated is exposed. It retracts toward the hilum and leaves gap-

ing and bare a huge cavity wherein putrefaction may occur and a large surface from which absorption can take place. It is most urgently necessary to close such ghastly wounds if it is physically possible. Gregorie has accomplished this in 17 cases of which 16 recovered.

2 Thoracotomy is formally indicated in all cases of wound of the lung causing hemorrhage. Suture of the lung tissue affords perfect hemostasis. When any foreign body projectile or sequestrum is felt, the lung is incised over it if necessary and after extraction of the foreign body the wound is stitched up accurately. Any blood lying in the pleura is carefully evacuated perfect cleansing of the cavity is insured and the wound is closed. It may be after a gentle wiping of the parts with ether. There is no need for drainage.

3 In the treatment of progressive emphysema closure of the wound in the lung will shut off the channel through which the air escapes into the tissues. Multiple skin incisions will relieve the tissues already distended and crepitant. In cases of simple penetrating wounds a cleansing and excision of the wounds followed by a complete approximation of the edges is all that is necessary. In many cases even excision is not required the points of entrance and of exit may be cleaned and covered with a sterile dressing.

When a hemothorax is present, no interference as a rule is needed for some days. There may be exceptions to this rule when the rapid or the large accumulation of fluid is causing urgent dyspnoea which threatens the life of the patient. The dangers of early aspiration of the fluid are of course related to the re-opening of the pulmonary wound which lightly sealed, may bleed afresh, as the lung expands. At the end of a week or thereabouts aspiration of the blood has probably a most beneficial effect upon the lung allowing it to expand much more rapidly than would otherwise be possible and preventing the formation of those dense crippling adhesions which may embarrass the free action of the lung for a long time to come or even permanently. Operation on cases in England in which the blood has been left in the

pleural cavity reveal an extreme density and a wide extent of adhesions. X ray examination also demonstrates the firm union that is formed between the two layers of the pleura. Withdrawal of the fluid is therefore most desirable its replacement during aspiration by oxygen allows more fluid to be taken and causes the minimum of distress to the patient.

In cases of large hemothorax which presumably have remained sterile and in which no active treatment has been adopted there is a protracted period of incapacity of the lung. I have seen such cases many months after the injury in which the percussion note was still dull, the breath sounds were absent or diminished the chest flat and the respiratory movements very restricted. On examination by X ray a greatly thickened pleura was diagnosed and immobility of the diaphragm observed on the affected side. If aspiration is performed the appearance of the fluid gives valuable information as to its condition in respect to bacterial infection. If the fluid closely resembles new port wine in color it is free from infection if it is clear and almost colorless the amount of blood contained is small most of the fluid is then the result of a pleuritic effusion. A turbid fluid like weak cocoa, or an effusion with any suspicion of offensiveness indicates that infection is present and that the condition is one to be treated as an empyema.

When a hemothorax has become infected then thoracotomy is necessary. In the early period of the war the operation was practiced on the lines of the civil operation for empyema. A short piece of rib was excised the putrid and most offensive fluid evacuated and a large drainage tube introduced. Such cases remain sometimes for weeks even for months with open wounds. Tuffier has modified profoundly for the better the treatment of these tedious and most trying cases by adapting to their needs the Carrel Dakin technique. The operation in so far as resection of the rib and evacuation of the fluid are concerned is precisely similar to the procedure in cases of empyema. But instead of one large tube several small tubes threaded with wire are placed over the cavity at well judged intervals. Their position and proper dis-

tribution may be confirmed if roentgenogram is taken. A little loose gauze is packed into the wound and a safety tube for drainage of excess fluid lies in one angle of the incision. Dakin's fluid is instilled in the usual manner. At the end of ten days all discharge (there is rarely more than an extremely small quantity after the first two days) has ceased and the tubes are therefore removed and the wound closed.

There is no doubt that many cases of suppurating hæmothorax would do better if operated upon quite early by a wide opening of the chest, and a complete clearing away of all masses of clot and pleural lymph often so tenaciously adherent, and by removal of any projectiles. Patients not operated upon or operated upon by the older methods linger on in unsatisfactory conditions for such long periods at home that every fair opportunity that offers for curtailing the tedious and not wholly safe period of their convalescence must be embraced. The Carrel-Dakin technique will here find one of its most valuable indications. This is only to bring the treatment of wounds of the lung into line with that practiced elsewhere. The surgeon no longer allows infection to be well established in the wound; his aim is to attack by approved methods (the free opening of the wound, the excision of all dead or contaminated tissue, the removal of all fragments of clothing of all projectiles and of all foreign bodies) and then to secure the earliest possible closure of the wound which remains. No less an ideal and no less scrupulous a practice should guide him also in the treatment of wounds of the lung and pleura. The time has gone by when he can justly allow an infection to become deeply ingrained before adopting those tardy in complete and often ineffective methods with which he has been too long content.

What is the history of patients in whose lungs projectiles are retained? Our knowledge does not allow us as yet to answer this question fully. But a certain experience is not likely to be changed by a larger survey of cases. We may say with confidence that a rifle bullet or a small piece of shell casing may be retained for months or years without causing distress and without affecting appreciably the normal functions of the lung in which it lies buried. But with large or irregular pieces of shell the case is different. I have seen many patients suffering for twelve or eighteen months from cough, with hæmoptysis at intervals. In two cases the loss of blood was serious. And in many patients there is an increasing complaint of pain, dyspnoea on exertion, and of expectoration of mucus.

For these reasons I have recently given special attention to these patients and have submitted a number of them to operation. The results so far entitle me to say that it is probably a safer as it is certainly a speedier procedure to submit all patients in whose lungs a large projectile is retained, to operation rather than to leave them untreated. In almost every case operated upon the projectile has been dropped at once into a culture medium with one exception all missiles were infected; the organisms most commonly found were staphylococci.

The following are the details of the procedure adopted for the extraction of bullets from the lung. The new features in the method are chiefly due to the initiative and the superb technical skill of Pierre Duval to whom I most gratefully acknowledge my indebtedness. The operation is performed in anaesthesia induced by ether and oxygen. A preliminary injection of morphine and atropine is given about half an hour before the operation.

The patient lies flat on his back, with the arms to the side. A curved incision about 5 or 6 inches in length is made exactly along the line of the fourth rib. The fibers of the pectoralis major are split, and the pectoralis minor separated from the rib. There are many points of hæmorrhage requiring a clip or a ligature. All must be carefully secured so that there is a perfectly dry field. The rib and the costal cartilage are exposed for a distance of not less than 5 inches. An incision is made through the pericostum midway between the upper and lower borders and this membrane is stripped from the rib on both surfaces. A Doyen's curved raspator is very useful for the purpose. In my earlier operations I cut through the costal cartilage and then divided the rib with forceps so that a

length of 4 to 5 inches of the rib could be removed. In later operations I have freed the inner end of the rib after division of the cartilage have passed a strip of gauze beneath it, and pulled it upward and outward. In this way the rib may be saved, and replaced at the end of the operation. This however is not a point of great importance for when the periosteum is left, a new rib is formed very rapidly and the chest wall soon becomes as firm as ever. Care is taken in excising the rib and in lifting it away not to wound the pleura, which must be separated widely from the ribs above and below to the inner and the outer side of the wound. Unless this is done accurate closure of the pleura later on always difficult, will be impossible. A retractor is now placed in the wound to widen the interval between the ribs above and below. Any abdominal retractor will do but the best instrument I have used is that invented for this special purpose by Tuffier. As wide a gap as possible is made so that the whole hand can easily be passed into the chest.

The pleura is now incised along the line of the rib and air enters freely and at once into the pleural cavity. As a rule this causes no disturbance and does not alter the rate of the respirations or of the pulse.

The hand is now passed into the chest cavity. Adhesions of the lung to the parietal pleura may be encountered. These are sometimes very slender and easily broken through. At times they are tough and strong and are with great difficulty severed. If they are numerous or thick and tough, bleeding may occur quite freely for a minute or two. With gentle pressure from a hot moist swab the oozing is soon checked. In a case where a projectile was in the base of the right lung posteriorly the whole of the lower lobe and a great part of the upper lobe were most intimately adherent to the parietal pleura. The adhesions however separated in just the same way as adhesions within the abdomen separate by gentle pressure and stripping. Thoracic adhesions bleed I think far more freely than those encountered in the abdomen. When all are loosened the collapsed lung lies free within the pleural cavity. It may now be seized with the fingers or with a special

light form of clip and drawn up to the anterior wound and, little by little, be coaxed out of the wound. It is surrounded as it appears by warm cloths soaked in normal saline solution. When a lobe of the lung is freely delivered it is palpated from top to bottom. Any projectile embedded in it is felt as a rule at once. Even little sequestra blown in from a rib may be recognized without any difficulty. These foreign bodies are as easily recognized as the particles of gritty sand in a new sponge. When the projectile is felt the part of the lung containing it is made prominent, the lung tissue lying over it is incised, the metal removed, and the wound sutured. Deep stitches of catgut are passed through the lung substance and with gentle tension act as a hemostatic.

If necessary very fine catgut sutures may be used to secure the accurate apposition of the pleural edges. If there is any bleeding from the collapsed lung it is slight and easily controlled but precision in suture is most desirable, for expansion of the lung will rapidly be secured when the operation is completed. If there are two or more particles of shrapnel or shell casing in the lung they are all dealt with in the same way. I have once incised the hilum of the lung and stitched it up without difficulty. When the sutures are completed the lung is replaced the cavity of the pleura most carefully dried and emptied and a gauze swab wet with ether wiped over the visceral pleura, and over any adhesions which may have been separated. The retractor is removed and the parietal pleura now stitched up. This is quite the most difficult part of the operation indeed I have not been able to close the pleura accurately unless this membrane has been stripped up freely from the chest wall before being incised. The rib if it has been turned back is replaced and fixed in position by a suture through the costal cartilage. The muscles are carefully sutured and the wound edges accurately approximated without drainage. The closure of the wound should be so carefully done as to seal the chest hermetically. When the dressing is applied, a two-way needle may be plunged into the chest, and the ether and air extracted therefrom. The lung then rapidly expands and



faint breath sounds are heard at once. No shock follows this operation.

#### CONCLUSIONS

The following general conclusions may be stated:

1. The approximate mortality from gunshot wounds of the chest at all parts of the line of communication is 20 per cent.

2. The causes of death are hæmorrhage as a rule within 24 hours and sepsis after the third or fourth day.

3. The local conditions in wounds of the chest wall and lung are in all respects similar to those met with in wound elsewhere. The missiles are the same, their destructive effects upon the tissues are the same, and the infecting organisms are the same.

4. The lung tissue is more resistant to attack than many other tissues. The opening of the pleural cavity and the resulting exposure of a large serous sac to infection and all its consequences add, however, a danger of the most threatening character.

5. The chief essential in the treatment of all cases of penetrating wound of the chest is rest.

6. In clean perforating wounds of the chest rest together with the cleansing and dressing of the wound of entrance or exit will lead to the recovery of the great majority of cases.

7. In cases of open thorax, the earliest and most complete effort possible must be made to secure closure of the wound after an appropriate toilet.

8. In those rare cases of grave hæmorrhage when hæmoptysis is present or when the blood escapes by the wound, a direct access to the

source of the bleeding must be obtained when all contingent circumstances permit, and the wound in the lung must be treated by suture, preferably, or by plugging of the cavity from which the blood escapes.

9. In cases of hæmothorax when the blood effused is small in quantity and remains sterile, no active measures are necessary unless absorption is long delayed. Aspiration repeated if necessary may then be performed.

10. In cases of hæmothorax when the blood effused is large in amount and remains sterile, aspiration after the seventh or eighth day, or earlier in cases of urgent dyspnoea, certainly hastens convalescence, permits a more rapid expansion of the lung, and prevents the formation of firm adhesions which may permanently cripple the free movements of the lung.

11. In cases of hæmothorax, whether the amount of blood is small or large, when infection takes place, open operation is necessary. Early operation, both when the Carrel-Dakin technique or Morison method are adopted, saves many weeks of convalescence and permits of a more perfect functional recovery.

12. Small foreign bodies or rifle bullets, imbedded in the lung, often cause no symptoms; they become encapsulated and may safely be left.

13. Larger foreign bodies retained in the lung may cause distressing or disabling symptoms for long periods. In such cases removal after resection or elevation of the fourth rib through an anterior incision will allow of the safe removal of the projectile from any part of the lung. Pieces of metal so removed are almost always infected.

## SODIUM PERSULPHATE IN THE TREATMENT OF TETANUS

By DR. L. LEYVA BOGOTA COLUMBIA

ANTITETANIC serum beyond a doubt has produced marvelous results but it does not always prevent tetanus and we who have worked in military hospitals have seen not a few cases which have been treated by means of tetanus bacillus injections with results which were almost invariably fatal.

Before the introduction of sodium persulphate in the American Hospital in Paris 75 per cent of the cases of tetanus ended fatally notwithstanding the fact that the hospital staff was excellent and there was at hand every requisite to carry out the most complicated technique.

It is true that the number of cases treated with persulphate of sodium is not large enough to establish its efficiency beyond question on the other hand it is quite possible that the fact that the patients who were treated in this way recovered while the others did not, is not due to pure chance.

These considerations impel me to publish the particulars of three cases which have been so treated and which I append hereto. Later when I have had the opportunity of observing more cases I intend to write a more lengthy article on the subject today I am content with presenting a few particulars so that my colleagues may know of the efficacy of sodium persulphate in the treatment of tetanus.

It is a fact that persulphate combined with the antitetanic serum relieves the pains and spasmodic attacks to such an extent that the patient begs to be given the injections.

The minimum dose must be 60 cubic centimeters in one day as was clearly proved by the third case in which there was no improvement until this dose was reached.

The solution must be freshly prepared, and must be kept cold and in a shaded place as both heat and light decompose it. In the American Ambulance Hospital the injection was prepared in doubly distilled water using

the persulphate of sodium in sealed bottles prepared by the firm Lumière of Paris.

CASE 1. Paul C. 35th Regiment of Infantry (French Army) age 20. Wounded on March 1, 1916 in the head, right arm and right thigh by the explosion of a shell. An injection of antitetanic serum was given at the first dressing and a second injection on the following day.

March 17 admitted to the American Ambulance. *Paris Symptoms* three wounds in the head, one in the left parieto-occipital region that exposed the bone, one in the frontal region and another in the right parietal region. The ring and middle fingers were amputated, the flaps of the stumps were septic and gangrenous.

There was a compound septic fracture at the lower third of the right femur, the wound was about 50 centimeters long and situated in the internal aspect of the thigh and had several drainage tubes which emerged through a counter opening in the postero-internal surface of the limb.

March 18 operation by Dr. Mignot. The site of the fracture was explored, and various loose splinters of bone were removed. This operation was performed for the purpose of removing the foreign bodies shown by the X-rays and to alter the position of drainage. No foreign body could be detected by means of the electrovibrator of Bergogne from Bordeaux. A counter opening was made in the postero-inferior aspect of the thigh. Carrel drainage was established and the wound was irrigated every two hours with Dakin's solution.

March 28 Acute irritation of the skin due to the Dakin's solution made necessary the discontinuation of this treatment and the wound was irrigated with hot saline.

April 3 and 4. Yodargol dressings.

April 5. In the course of the afternoon the patient experienced difficulty in opening his mouth and complained of headache and pain in the neck.

April 6 Tetanus was diagnosed. First injection of antitetanic serum fifteen thousand units preceded by an intravenous injection of two thousand units of the same serum to guard against the anaphylaxis.

April 7 Three intravenous injections of 20 cubic centimeters each of antitetanic serum were given. The patient became worse. Trismus became complete and the spasmodic contractions of the muscles of the neck and shoulder were more frequent and stronger spasmodic contractions of the diaphragm were extremely distressing owing to embarrassment in respiration.

Dr. Mignot advised Lumière's treatment of intravenous injections of sodium persulphate dose 20

cubic centimeters of a 5 per cent solution freshly prepared. First injection at 2 p.m. given very slowly (five milliliters were taken in injecting the liquid). After the injection the patient had nausea and vomiting for half an hour but the respiration became easier. Second injection at 9 p.m. accompanied by a subcutaneous injection of 10 cubic centimeters antitetanic serum. The same symptoms were produced.

April 8. Diaphragmatic contractions seemed to be less intense otherwise general conditions similar to previous day. The muscular contractions displayed the fragments of the fractured femur and produced attacks of excruciating pain. Three injections of sodium persulphate were given at 8 a.m., 2 p.m. and 9 p.m. respectively. Notwithstanding the nausea that followed the patient himself begged for the injection and said that it alleviated the pain and allowed him to sleep.

April 9. Intravenous injections of sodium persulphate were given once this morning and once in the evening also a subcutaneous injection of 10 cubic centimeters antitetanic serum. The temperature rose to 38.5 F.

April 9. Only two injections were given. The patient is being rather better.

April 10. Two injections of sodium persulphate. April 11. Symptoms of bronchopneumonia with marked physical signs at the base of the left lung. The pulmonary symptoms and signs subsided in three days during this period only one injection of sodium persulphate was given daily as the cough seemed to be worse after the injections.

April 12. Patient had a better day. The spasms were less frequent and the trismus was commencing to yield. Two injections of sodium persulphate were given at 8 a.m. and 5 p.m. respectively.

April 16. One injection of sodium persulphate and one of antitetanic serum. Temperature rose to 39.5 F. and the muscular contraction of the thigh became more frequent than in the previous day. Three injections of sodium persulphate and three antitetanic serum. The third injection was followed by reaction characterized by vomiting and malaise.

April 17. Two injections of sodium persulphate and antitetanic serum at 9 a.m. and 5 p.m.

April 18. Same treatment at 8 a.m. and 7 p.m.

April 19. One injection at 9:30 a.m.

April 20. One injection at 9:30 a.m.

April 21. One injection at 9:30 a.m. The injection of sodium persulphate and antitetanic were given simultaneously. The symptoms and signs of tetanus disappeared and the general condition of the patient was greatly improved, but a patch of bronchial pneumonia was detected in the left lung. This was successfully treated by dry cupping and subcutaneous injections of gamenol oil.

The patient was removed from the isolation of a general ward. Extension was reapplied to correct the displacement of the segments of the fracture

caused by the muscular spasms. The patient was free from symptoms of tetanus until July 14.

July 15. Headache. Beginning of trismus. Patient said he experienced similar sufferings to those that he had had at commencement of attack of tetanus. Antitetanic injections were immediately given. The same process to ascertain the presence of anaphylaxis was employed.

July 16. Two injections of sodium persulphate with one of antitetanic serum.

July 17. Two injections of sodium persulphate with one of antitetanic serum.

July 18. Two injections of sodium persulphate with one antitetanic serum.

July 19. Two injections of sodium persulphate with one of antitetanic serum.

July 20. Two injections of sodium persulphate with one of antitetanic serum.

July 21. Two injections of sodium persulphate with one of antitetanic serum. Patient better.

July 22 and 23. One injection of sodium persulphate and one of antitetanic serum.

July 25. Patient cured. This second attack had not been so severe as the first one.

A Gust 8. Operation by Dr. Mignot. On reopening the wound the femur was found stripped of periosteum for a length of 4 centimeters. Three large sequestra were removed. Drainage tube in the posterior aspect of the thigh. The wound was treated with Dakin's solution until September 20. September 23. Operation by Dr. Leyva.

Two prophylactic injections of antitetanic serum. A longitudinal incision 10 centimeters in length was made in the anterior surface of the right thigh. The bone was exposed and a round sequestrum 6 centimeters long was removed. The wound was plugged with iodoform gauze. On attempting to remove the knee joint the femur was refractured. An extension was applied the same day and the bone re-united in better position.

The patient left the hospital December 15. The right knee was ankylosed but the fracture of the femur had united in good position. There was one centimeter shortening. The wounds of the head and hand were perfectly healed.

CASE 2. Lucien C., 2nd Regiment *Chasseur à pied* age 23. Wounded on November 16, 1916 by the explosion of a shell. Dressed at the clearing station and operated on at a base hospital for extraction of shrapnel. Also an injection of antitetanic serum was given.

On admission to American Ambulance, Paris, the patient had several septic wounds: one on the dorsum of the left hand, one on the middle third of the left leg, a superficial one in the middle third of the right leg, another superficial wound just above the articulation of the right knee, a compound fracture of the third metacarpal bone, and finally, a suppurating wound which involved the right shoulder joint.

The roentgenogram showed a small piece of shrapnel in the left hand and confirmed the fracture

of the third metacarpal it also demonstrated the presence of another piece of shrapnel near the head of the right humerus also in the lower third of the left leg and in the upper third of the right leg.

November 2 Shrapnel was extracted by Dr Johnson.

December 2 The patient complained of acute pain in the left leg. In the evening there were symptoms of tetanus. The temperature remained normal (the pains resembled lightning pains).

December 3 The treatment with sodium persulphate was begun. As the case was not a severe one only one daily injection was given up to 12. The patient experienced only slight relief after the injection but there was no alteration in the symptoms until December 11 when the temperature rose for the first time to 100.2 F. As it was considered that one daily injection was not sufficient two were given. Two days later the muscular contractions were less frequent and the pain much less intense.

December 14 Tetanic contractions and pain had almost disappeared, and the treatment was continued until December 16. From this date all medications stopped. The flexors of the thigh became permanently contracted and the leg remained in a position of complete flexion.

CASE 3 Henri F. Regiment 320 Infantry age 32. Wounded by a bullet July 5 1916. First dressing at a clearing station where an injection of anti-tetanic serum was given four hours after injury. The patient was treated during the following eleven days at a base hospital where he was operated on for extraction of spicules of bone. Drainage of the wound was established. Admitted to the American Ambulance Hospital of Paris on July 18.

On admission the general condition of patient was satisfactory. A large wound extending from the right coracoid process to the middle of the spine of the right scapula. The pectoralis major muscle was divided and the glenoid cavity could be seen at the bottom of the wound. The head and the upper fourth of the humerus had been blown away. The wound was drained by two large tubes which passed from the anterior part of the arm to a counter opening in the postero-internal aspect. There was no injury of any nerve. The wound was perfectly clean.

July 19 The roentgenogram demonstrated a fracture of the humerus and the absence of the head and surgical neck of the same.

Treatment by Carrel's method was started

July 20 21 and 22 Normal improvement suppuration less temperature normal.

August 1 The improvement continued until the evening of this day when the patient complained of sharp pain in the arm but it was not until August 3 that muscular contractions accompanied the pain. Some trismus was present and palpation of the neck revealed contraction of the sternocleidomastoid and later some limitation of extension. At the same time the temperature rose to 102 F. The diagnosis of tetanus was established and at 6 p.m. and injection of 10 cubic centimeters of antitetanic serum was given preceded by an intravenous injection of one thousand units of the serum to ascertain the presence of anaphylaxis. At 10 p.m. 20 cubic centimeters sodium persulphate 5 per cent solution was given. At 10 p.m. injection was repeated, accompanied by another injection of 10 cubic centimeters antitetanic serum.

August 5 The patient's condition became worse. The trismus and rigidity of the neck became more pronounced both pain and muscular contractions of the arm were more frequent. At 9 a.m. 10 cubic centimeters of sodium persulphate and 20 cubic centimeters of antitetanic serum were administered. At 2 p.m. these were repeated and also at 10 p.m.

August 6 The tetanus began to subside the muscular contractions were weaker and less frequent. The strongest took place at the moment of the injections which were given in the same doses as in the preceding day. Temperature lower.

August and 8 Same treatment.

August 9 The temperature subsided. The patient was able to open his mouth from one to two centimeters.

August 10 11 and 12 The same treatment. Improvement continued less pain and the mouth could be opened more easily.

August 20 Improvement became more marked, only 2 injections of sodium persulphate and one of antitetanic serum were given.

August 21 The cure was almost complete. One injection of sodium persulphate.

August 23 The patient was transferred from the isolation to a general ward. The healing of the wound was steadily progressing and was still treated with Dakin's solution.

September 28 The patient was discharged in good condition. The wound was nearly closed (there was no union of the fracture). There was a pseudo-arthritis of the humerus.

A STUDY OF THE RECTOSIGMOID<sup>1</sup>

B. WILLIAM J. MAYO, M.D., R. I. MISSOURI

THE rectosigmoid the narrowest part of the large intestine consists of 5 inches of the intestinal tract which includes the terminal 2 inches of the sigmoid and the proximal 3 inches of the rectum. It is a definite mechanism which retards the faecal current and prevents continuance of the intestinal contents into the rectum. The examination of a large number of men in the army service demonstrates that in the adult the normal rectum does not retain faeces for any length of time and when it does such action is artificial and pathologic. With the exception of the pyloric end of the stomach and the first portion of the duodenum the rectosigmoid is more frequently diseased than any corresponding portion of the gastrointestinal tract.

In the older anatomy the terminal 2 inches of the sigmoid was often if not usually called the first portion of the rectum because of certain anatomic peculiarities which rendered it difficult to say with certainty whether it was sigmoid or rectum. Following the researches of Treves and Jonnesco it was definitely concluded that this portion of the intestinal tract was a part of the sigmoid and it is so designated in all of our later anatomies. The rectum proper begins at the middle of the third sacral vertebra and anatomically speaking ends at the level of the apex of the prostate in the male and at the upper level of the perineal body in the female sites which mark the beginning of the so-called second portion of the rectum. It more correctly ends the anal canal.

The anal canal of Symington has its origin in the proctodeum or skin infold. It is lined with pavement epithelium, has no mucous glands and is in no way a part of the rectum but is rather a retentive mechanism extraordinarily well adapted to temporary rectal retention. The anal canal is about 3 centimeter in length, and passes upward and forward at such an angle in relation to

the musculature of the rectum as to relieve the strain on the sphincter muscles. This valve type of mechanism is exhibited in the compression of the ureter in the wall of the bladder and of the common duct in the wall of the duodenum. Its most important artificial imitation is shown in the brilliant work of Coffey which has made transplantation of the ureters to the large intestine an operation of safety and precision.

The rectum is therefore a single organ averaging 11 centimeters in length, with a protective sigmoid mechanism above and the sphincter apparatus of the anal canal below. The upper of the two left valves of Houston which is nearly always discernible although sometimes rudimentary lies just below the inferior margin of the terminal sigmoid constriction. The lower left valve of Houston lies below the level of the peritoneum while the single large right valve which is nearly always present projects well across the lumen of the rectum near the mid point.

The ampulla of the rectum may be described as the sacculated portion lying between the anal canal and the lower left valve of Houston. The middle portion of the rectum ends above at the right valve while the upper rectum extends to the sigmoid at the upper left valve. The index finger of the average examining hand when the anal canal is forcibly elevated can reach to and often a little above the right valve of Houston but not to the rectosigmoid juncture (Fig. 1).

This interpretation of the anatomy of the rectum is in harmony with its embryologic origin. The rectum proper is derived from the cloaca a highly differentiated part of the hind gut from which also the bladder is derived. Definite anatomic changes are to be found in the epithelial layers of the mucous membrane at the rectosigmoid juncture and possibly a tissue weakness worthy of note.

The terminal 2 inches of the sigmoid

(Fig 1) has considerable resemblance to the lower rectum just above the anal canal. The more or less circular folds of the mucous membrane of the sigmoid here take on a longitudinal arrangement with much the appearance of the columns of Morgagni and the rectal sinuses and end in a rudimentary sphincter apparatus at the very beginning of the rectum. This hint of a sigmoid sphincter at the rectosigmoid union forms a well marked resisting constriction to the readily dilatable sigmoid above and the rectum below (Jonnescio Markel)

Examination shows that this circular band at the termination of the sigmoid contains considerable non striated muscle fiber (Figs 1 and 2). Clinically there is often seen through the proctoscope when the patient strains during examination a tendency of the movable sigmoid to project through this muscle band as a slight intussusception into the fixed rectum. Tumors in the terminal sigmoid are not infrequently intussuscepted into the rectum giving the diagnostician on digital examination the erroneous impression that they are rectal.

Through the kindness and with the aid of Dr C M Jackson head of the Department of Anatomy University of Minnesota Dr T B Reeves at my request carefully dissected the rectum in forty six cadavers. The terminal sigmoid constriction (Figs 1 and 2) was found in 80 per cent and in two of the forty six it amounted to a definite narrowing which reduced the caliber of the rectosigmoid juncture to a considerable extent. This narrowing seems to have attracted little attention from surgeons and in the large majority of cases it is so slight as to be readily overlooked (Fig 1). In addition the anatomy was very carefully worked out in the cases presented for operation and the drawings are the result of these combined studies.

Examination of the rectosigmoid that is the part of the rectum which lies above the right valve of Houston and the terminal 2 inches of the sigmoid from the inside shows not only those definite changes in color and arrangement of the mucous membrane which characterize the rectum and sigmoid re-

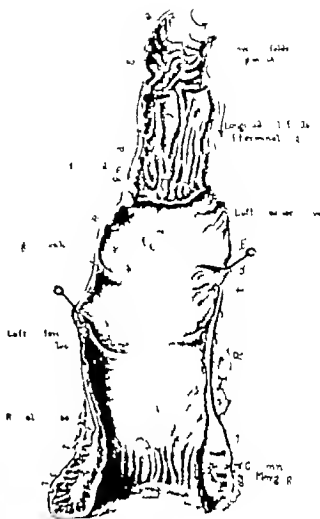


Fig 1 Terminal sigmoid rectum, and anal canal from inside

spectively but also in a high percentage of subjects the rudiments of the terminal sigmoid sphincter which defines the two organs. Examination of the outside of the rectosigmoid discloses prominent features of identification: (1) The rectum has no mesentery; (2) the longitudinal muscle bands of the sigmoid spread out making a complete longitudinal layer for the rectum; (3) the superior rectal artery divides into the right and left branches at the origin of the rectum; and (4) the absence of epiploic tags which are found on the sigmoid to its end (Fig 2).

The impression is gained that ordinarily the rectosigmoid is an arrangement for re-

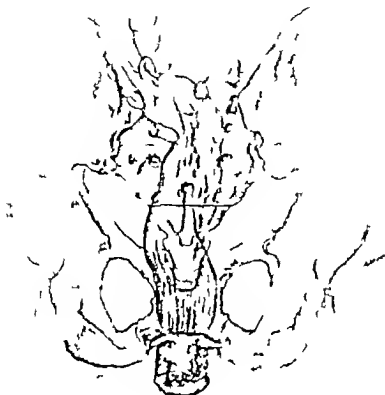


Fig. 4. Terminal sigmoid, rectum and anal canal seen from behind, with relation to bony pelvis.

tention of contents in the sigmoid proper and that under certain circumstances the controlling mechanism may subject the parts to undue stress.

The rectosigmoid apparatus is controlled by the pelvic plexus of nerves which is made up of a variable number of sympathetic ganglia joined from above by spinal nerves from the lumbar region and from below by spinal nerves from the sacral region. From the lower part of the pelvic plexus nerves can be traced into the recto-sigmoid region and the rectum. The inferior mesenteric plexus containing a variable number of sympathetic ganglia follows along the course of the superior hemorrhoidal artery and helps to supply the rectosigmoid and the upper part of the rectum. According to Langley and others the nerves derived through the hypogastric plexus are inhibitory

in action while those from the spinal and sacral nerves are motor (Fig. 4).

In addition to the nerves mentioned the smooth muscle fibers which compose the musculature of the rectosigmoid like all non striated muscle fibers, have the power of originating contraction and according to Keith, these impulses are collected in certain neuromuscular nodes and correlated. Failure of co-ordination results in a most curious and interesting pathologic phenomenon the so-called idiopathic dilatation of the colon, or Hirschsprung's disease. A number of cases of this condition have been recognized since the attention of American surgeons was called to it by Finney. The disease is similar in origin to cardiospasm at the cardiac orifice, pylorospasm and stasis at the ileocecal valve.

The terminal sigmoid, as held by its men-







hospital Rochester Minnesota it was found that 23 were located in the rectosigmoid juncture extending as much onto the rectal as onto the sigmoid side 21 involved the juncture but extended more onto the rectal than onto the sigmoid side 14 involved the juncture but extended more onto the sigmoid than onto the rectal side Thus 63 per cent involved the rectosigmoid 30 per cent the rectum only and 7 per cent the anal canal

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## POSTOPERATIVE PULMONARY COMPLICATIONS<sup>1</sup>

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### INTRODUCTION

THERE is a somewhat smug satisfaction and comfort to the surgeon in the phrase unavoidable surgical calamity. Under this heading surgeons often feel justified in placing some of the fatalities of surgery and more especially the post operative complications of pulmonary embolism and a certain number of the post operative pneumonias commonly known as ether pneumonias. But for those who have carefully studied and observed such cases and have sifted out all the underlying factors and possibilities which might be considered in their etiology this phrase loses in its persuasiveness. In a majority of instances thorough analysis reveals factors that remove the case from any class labeled unavoidable calamities and we have found that the general condition of the patient the presence of sepsis or pre-existing lung pathology or unjustifiably long or radical operation was often sufficient to explain any subsequent untoward result. In the ultimate analysis poor judgment is more often a tenable expression. Such criticisms sound harsh, but the truth is often brutal and it is only by thus

frequently checking up our own failures that we realize them. Taking our mishaps one by one they are soon forgotten and we may be led to believe that our results are better than they appear in cold figures.

This study was undertaken at the suggestion of Dr Porter and Dr Scudder chiefs of the two surgical divisions of this hospital because of the occurrence of a large number of postoperative pulmonary complications during a rather short period of time. We have taken the cases operated upon during the year July 1915 to July 1916 at the Massachusetts General Hospital. During this period there were 3490 operations which include the major operations of the Throat Genito-Urinary and Orthopedic Departments as well as the work of the General Surgical Services. Thus our study embraces the most varied and general class of patients and operations. The majority of the patients are from the city and we cannot boast that their average well being is such as to offer good surgical risks but with the addition of the few patients that come in from the neighboring country the average is brought up to at least an ordinary safe risk. We make

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this point in discussing the wide general field both to the operation and type of patient since it is only by a true realization of these factors that any honest comparison can be made with the many reports on postoperative complications from other clinics.

In our analysis we have studied the records critically with especial reference to the pre-operative condition more particularly pulmonary to the general course amount and type of anesthesia and to the postoperative course of the cases. We have included all postoperative cases developing lung complications and our problem has been to try to bring forward some of the causes or at least the contributing factors of these complications. Terminal lung conditions as in general sepsis we have not included since the pulmonary trouble is merely a side issue. Also we have excluded the lung complications of lung abscess operation and operations for empyema because of the certainty of further pulmonary involvement in every instance. We have been particularly anxious to keep the problem broad and not to confine it to a study of the anesthesia risk alone or to the pneumonia alone or to the risk in any given field of operation.

Very few papers have discussed the subject from the aspect of postoperative pulmonary complications as a whole and more often it is presented as a study of a single pathological entity aether pneumonia or pulmonary embolism or a study of the lung complications following a definite type of operation, or in a limited field, and is not a summary of the incidence of such sequelae in the entire realm of surgery. Therefore such a review as ours because of the diversity of its scope may not seem to point so sharply the dangers of operation in any given field but we feel that it serves a valuable purpose in calling strongly to attention the very certain risks involved by any operation, and more especially the added dangers in a few anatomical regions and with certain types of patients.

We are particularly anxious to point out that a careful study of the pre-operative risk as shown by already existing lung pathology

See Section

old age general debility and poor circulation will reveal sources of what may often result in fatal postoperative complications. Thus it is really the judgment of surgeons as to the pre-operative general risk that we hope chiefly to bring under fire. This criticism naturally does not apply to the few urgent surgical conditions demanding immediate interference. In addition, our statistics add to the mass of evidence which demonstrates the high incidence of postoperative pneumonia and the greater proportional occurrence of lung complications in operations in the upper abdomen and upon the face and neck.

We would refrain from discussing methods of anesthesia were it not that many consider that postoperative pulmonary complications are to a great extent dependent on this factor. Anesthesia in this hospital is given (1) by nurses who are specially trained and chosen to do this work only and whose experience is considerable and (2) by the junior house officers. On rare occasions a professional anesthesiologist takes over a case. The work as a whole is fair certainly up to the average but not above criticism. Mallinkrodt's ether is in routine use.

The semi-open cone method of giving ether is used for straight ether the Bennett inhaler followed by the cone for the gas and ether sequence and the Ohio monovalve apparatus (Crile) for the gas and oxygen or gas, oxygen and ether anesthetics. Anesthesia is dropped on an open mask. As a rule morphine grains 6 and atropine grains .30 are administered about one half hour before operation. Other than the customary toothbrush and a simple cleansing alkaline mouth wash (modified Seiler's mixture) no especial effort is made to establish oral asepsis except in the gastric cases and those having operations about the mouth. In these two groups it is the rule to have a thorough investigation and prophylactic treatment by a dentist. The field of operation is shaved cleansed and covered by a sterile dressing the evening before operation. Laxatives the day before, and an enema the morning of the operation are given to ensure an empty bowel.

In our series of 65 postoperative pulmonary complications in 3490 cases the kind of

anesthesia used and the resulting postoperative lung complication with the different anesthetics are shown in the accompanying table

# POSTOPERATIVE COMPLICATIONS FOLLOWING DIFFERENT ANESTHETICS

	Straight Ether	Gas and Ether	Gas, Oxygen, Ether	Gas and Oxygen	Anesthetized	Local (Novocaine, Cocaine, Etc.)	Ruber Anesthetized	Totals
Lobar pneumonia		4			(apical also)	1		5
Pneumonia		1						1
Bronchitis	5							5
Pleurisy	1							1
Empyema								
Pneumothorax								
Mediastinitis								
Pulmonary embolism	1							1
Lung abscess								
<b>Totals</b>	7	5						12

The above classification into types of pulmonary disease is arbitrary and is order not to count single cases twice, when patient had two or more complications, we have recorded such cases under the pathological entity which we have felt was chiefly at fault.

The greatest difficulty we have found to be that of classification. In the great numbers of studies of this subject especially in the German reports there is the widest variation as to the method of classification. The subject may be divided into (1) pathological types (pneumonia pleurisy etc) may be arranged (2) according to the time incidence (late or early) studied (3) in relation to the method or kind of anesthesia classified (4) as to the method of infection (embolic, aspiration, or irritative) or (5) analyzed according to the pathways of infection (air passages blood stream lymphatics)

## PRESENTATION OF MATERIAL WITH POST OPERATIVE PULMONARY COMPLICATIONS

Our analysis covers 3490 cases operated upon during the year July 1915 to July 1916. In this number 65 cases presented definite postoperative pulmonary complications. We feel that in addition several cases with a mild bronchitis or a transient pleurisy escaped classification in the hospital records through not being sufficiently recorded in the post operative notes. Both of us personally remember such instances and others must have escaped our notice. None of the fatalities however can be included in this number so

that the percentages are not appreciably altered by their absence.

Considered broadly as pathological types the pulmonary complications fall into the following clinical groups pneumonia lobar and broncho bronchitis pleurisy empyema mediastinitis pulmonary embolism pneumothorax and lung abscess.

We have classified our material under these main headings and will review the groups individually and try further to subdivide them according to time of onset after operation pathway of infection, anesthetic employed etc. The absence of necessary data and of sharply defined lines renders any classification imperfect and admittedly arbitrary. The occurrence of pulmonary complications with morbidity and mortality percentages is shown in the accompanying table.

## PULMONARY COMPLICATIONS

Complications	Number of Cases	Morbidity Per Cent	Number of Deaths	Mortality Per Cent of Morbidity	Approximate Morbidity per 100 Cases	Approximate Mortality Per Cent
Pneumonia Lobar Broncho	9	54		57.0 5.4	58.18 5.00	62.7
Bronchitis	7	30		00	40.7	
Pleurisy	5	14		20	69.7	31.00
Empyema		04		50	74.5	31.00
Mediastinitis	1	08	1	00	61	63
Pulmonary embolism	6	7	6	00	58	100
Pneumothorax		05		00	74.5	
Lung abscess		00		00		
<b>Totals</b>	65	8	11	40.7	61.4	30.6

**Lobar pneumonia** The majority of post operative pulmonary complications fall into the pneumonia group with the number about equally divided between the lobar and disseminated types. This is to be expected since it is into these classes that fall the complications commonly attributed to the anesthesia (Lord 1). The greater proportion of the cases, where irritation from the anesthetic might be taken as the chief factor (the so-called ether pneumonia group) fall into the group of lobar pneumonia while the cases of embolic origin naturally develop broncho-

pneumonia occasionally of the widely disseminated septic type. We will undertake to discuss the cases more or less in relation to the time of onset of the pulmonary condition after operation, for we find that when taken in this relation the cases fall naturally into fairly well-defined groups. These groups are constituted as follows: (1) cases with pneumonia already present at entrance and operated upon through necessity or because of a mistaken diagnosis; (2) cases developing pneumonia within a few hours to three days in which it seems that the condition may be chiefly attributed to the effects of the anesthesia and which are commonly called the irritative class; (3) a few rare cases in which the postoperative aspiration of gross food particles, blood or mucus seem at fault; and (4) the cases developing later in the convalescence in which the embolism of bacteria alone or of small septic plugs seems the most probable source of infection.

In the lobar pneumonia class there are 19 cases divided as follows: Class I, three cases with pneumonia present when operated upon, Cases 1, 2 and 3; Class II, eleven cases developing pneumonia within four days, i. e. within a period so close to the time of operation that blame at least in part may be placed upon the anesthetic. Cases 4 to 14 inclusive. Class III, one case, 15, pulmonary lesion evidently due to the postoperative aspiration of food particles; and Class IV, four cases in which the pneumonia developed on the fourth day or later and which careful study has led us to believe have as their etiology emboli from the field operated upon. These are Cases 16 to 19 inclusive.

The separation of the cases into these four main classes is admittedly arbitrary for no sharp lines can be drawn but it seemed necessary to make some division to facilitate comparison and study. The group of cases having pneumonia already present at entrance needs no further comment. It is inevitable that in any large series of lung conditions the signs and symptoms of pneumonia may simulate those of cholecystitis as in Case 1 or of appendicitis as in Case 7 and though it is regrettable that a more thorough chest examination was not made in these cases it must

be remembered that often the pulmonary signs may be very difficult to appreciate at a time when other symptoms are in the foreground. Case 3 obviously demanded operation.

Into Class II the irritative type fall the majority of the lobar pneumonia cases, 11 out of 19. As a group this class is well defined but individual cases in it, as Cases 12 and 14 may appear atypical. This will be true in any classification where the divisions are indifferently made. Case 12 presents the possibility of etiology other than irritative. Here the process was confined apparently to one base and there was considerable purulent sputum. One may justly suspect the flaring up of some unrecognized pre-existing lung condition possibly a metastasis or a latent bronchiectatic cavity. The presence of râles before operation must not be underestimated and the short course and fatal termination urge one to suspect the pneumonia was more widespread than diagnosed. Case 14 had a definite pre-operative lung pathology, was an old man and a poor risk, and though no frank signs of pneumonia were present until the fourth day unquestionably the consolidation began earlier and was merely an extension from the pre-existing condition. The other cases in this class, 4 to 14, exclusive of the two above mentioned are fairly clear cases of pneumonia setting in soon after operation and most frequently involving both sides. Several of these cases were bad risks but some were the opposite. In no case was there clinically a history of embolism and no particular opportunity for the postoperative aspiration of food mucus or other material. These cases seem to constitute a very definite group where the irritation of the anesthesia is immediately followed by pneumonia. An individual consideration shows that in addition to the irritation of the anesthetic there was always present, except in Case 10 further contributory factors. In five instances, Cases 7, 9, 12, 13 and 14, there was a definite pre-existing lung pathology; in two instances sepsis without the lung was present, in Case 6 associated with anemia and in Case 11 with extreme age. Cases 4 and 8 developed considerable shock, and in 5 the possibility of

lung metastases must be considered. Thus in all but a single instance there was superimposed on the irritation of the anaesthesia additional factors. The single exception Case 10 is further interesting in that it made a perfect recovery to normal.

Class III is as definite as Class I for it is self-evident that operations after which food or mucus may be aspirated into the lung will be followed by lung complication in a certain percentage. Case 15 is typical of this group. A resection of the tongue was done with the result that the patient experienced constant difficulty in swallowing. Food mucus and liquids were frequently sucked into the lung and a fatal pneumonia resulted. As was expected the lesions were rather disseminated and a purulent bronchitis was present as well as the pneumonia.

Class IV the embolic group is more difficult to define. Emboli may come by the lymphatics or by the blood stream may be large or small septic or sterile. (Homans 2). Because of this diversity of type the cases need more individual discussion. Case 16 at once may be labeled a questionable case for the rapidity of onset the bilateral involvement, as well as the poor risk tempt one to call it another case of irritative pneumonia. Irritation was a factor in part but with so much sepsis present before operation we feel that though the irritation paved the way, the source of the pneumonia was most probably small emboli possibly only bacterial (pyæmia) from these foci. In the true irritative type we feel that the organisms infecting are probably those already present in the lung which are merely given an excellent foothold. Case 17 after a fair operative recovery had an attack of pain in her side followed by pneumonia. While improving from this she very suddenly died making us suspicious of a pulmonary embolus. Case 18 ran much the same course but the pneumonia was followed by a septic pleurisy with effusion, which we think is a further argument favoring the embolic nature of the original infection. Case 19 had an uneventful convalescence for 14 days when consolidation of the lower lobe occurred. There had been no exposure or other known factor yet the lesion was well

marked. Hypostasis must be considered but with a freshly healed wound we prefer to attribute the etiology to the setting free of small emboli from the field of operation through bodily activity.

(NOTE.—In the following abstracts of cases we have stated the pre-operative diagnosis, the pre-operative condition only so far as it has possible bearing on the subsequent pulmonary condition, the operation and the postoperative course. Autopsy findings stated when procured.)

CASE 1. E. O. B. female age 61. May. Diagnosis cholecystitis suspicious of pneumonia. Patient well developed and nourished. Heart and left chest normal. The right chest showed dullness at the base rales and bronchial breathing. Cholecystostomy for acute cholecystitis (?) performed patient in dorsal position. The anesthetic was gas and ether 6 ounces and was administered for a period of 15 minutes. Operation lasted 25 minutes, and the patient was unconscious for 1 hour and 30 minutes. The anaesthesia was of a good general character with no accumulation of mucus and no vomiting. On return of consciousness the patient was nauseated and vomited. The patient made a fair recovery but pulse and respiration steadily rose. In 24 hours the right back was solid with rales and bronchial breathing. White blood corpuscles 14,000 day of operation, two days later 12,000. The patient died. No autopsy.

CASE 2. M. G. male age 14. December. Diagnosis subacute appendicitis (?). Patient fairly well developed and nourished with heart normal. The right upper back and both bases showed dullness with rales. Appendectomy performed (no real process) patient in dorsal position. The anesthetic was gas 50 oxygen 10 and ether 1 ounce and was administered for a period of 45 minutes. The operation lasted 40 minutes. Patient was unconscious for 3 hours. Anaesthesia was well taken. There was no mucus no nausea or vomiting on return of consciousness. Patient made good recovery on pneumonia régime but had pain in back and increase of signs in right back. After 4 days patient better by lysis. Discharged relieved.

CASE 3. W. J. P. male age 5. April. Diagnosis foreign body (pin) in trachea. Patient's left chest dull and breath sounds distant no rales or bronchial breathing. Heart normal temperature 104 pulse 136 respiration 50. Esophagoscopy and bronchoscopy performed tracheotomy with removal of pin from trachea patient in Rose's position. The anesthetic was ether small amount well taken. Patient made fair recovery. Bronchial breathing over area previously dull within 24 hours. Crises on the fourth day. Discharged relieved on the twelfth day.

CASE 4. J. F. D. male age 44. Diagnosis, megacolon and duodenal ulcer. Patient in good condition thin but well developed. Heart and lungs normal. Anterior gastro-enterostomy per-

formed patient in dorsal position. The anesthetic was gas and ether 20 ounces and was administered for a period of 1 hour and 40 minutes. Operation lasted 1 hour and 26 minutes and the patient was unconscious for 3 hours and 30 minutes. The anesthesia was poorly given and taken. Respiration irregular and poor, color variable and vomiting during operation. Patient made poor recovery rapidly failed. Clinical evidence pneumonia only slight. Died in 4 hours, probably shock. Autopsy: lobar pneumonia, chronic pleuritis, isolated tuberculous in pericardium septicaemia (streptococcus in sinus capsularis).

CASE 5 J. M. L. male, age 59 Jun. Diagnosis: hypernephroma with liver metastases. Patient in excellent condition, strong, well developed and unharmed. History pneumonia once years previously. Heart normal, no murmurs. Lungs clear and respiratory rales. Exploratory laparotomy performed with ascular nodule in liver patient in dorsal position. The anesthetic was ether 24 ounces, and was administered for a period of 45 minutes. Operation lasted 3 minutes. Patient was unconscious for 1 hour and 45 minutes. Anesthesia was well taken. Rapid operation, the patient struggling, nausea or vomiting. No nausea, muting or cough returned to consciousness. Patient made good recovery but in 3 days there were crackles in the right base in 48 hours definite signs of consolidation. Pulse, temperature and respiration up. Died in 4 days. Typical lobar pneumonia. Good reaction. Autopsy.

CASE 6 M. H. female, age 4 February. Diagnosis: chronic appendicitis (?) duodenal ulcer. Patient anemic and undernourished. Heart normal and lungs clear. Epigastric incision appropriate. Patient in dorsal position. The anesthetic was ether 20 ounces and was administered for a period of 1 hour and 6 minutes. The anesthesia was well taken. There was postoperative nausea, vomiting, and headache no shock. Patient made fair recovery with some vomiting on the following day in 24 hours consolidation at both bases. Cleared up in 4 days.

CASE 7 H. B. male, age 36 February. Diagnosis: duodenal ulcer. Patient had chronic bronchitis and coarse rales in left lung when admitted. Waited 10 days before operation. Heart normal. Infolding of ulcer and posterior gastro-enterostomy performed patient in dorsal position. The anesthetic was ether, 22 ounces, and was administered for a period of 1 hour and 40 minutes. Patient was unconscious for 4 hours and 45 minutes. Anesthesia well taken. There was postoperative vomiting no shock. Patient vomited much on day following the operation. Temperature up. In 3 days rales and froction rub then consolidation at both bases. Cleared up in two weeks.

CASE 8 C. G. male, age 65 April. Diagnosis: pyloric ulcer. Patient an old man in fair condition. Lungs clear and normal. Pylorotomy and posterior gastro-enterostomy performed. The anes-

thetic was ether 20 ounces, and was administered for a period of 1 hour and 26 minutes. Operation lasted 2 hours and the patient was unconscious for 3 hours. Anesthetic was well taken. Some shock. Patient made a fair recovery. On the following day there were marked signs of consolidation in both chests. Died on sixth day after operation. No autopsy.

CASE 9 C. R., female, age 65 May. Diagnosis: carcinoma of cervix. Patient in very poor condition, anemic chronic bronchitis with aneurism (subclavicular) markedly arteriosclerotic. Excision pedunculated malignant polyp patient in lithotomy position. The anesthetic was ether (record missing). Short operation, anesthesia well taken. Day after operation, temperature respiration elevated, cough. Temperature irregular 6 days dullness at both bases sudden rise in temperature (101°) sixth day irrational. Died on twelfth day. No autopsy.

CASE 10 S. F. male, age 20, February. Diagnosis: duodenal ulcer and gall-bladder adhesions. Patient in excellent condition. Heart normal and lungs clear. No rales. Infolding ulcer and posterior gastro-enterostomy performed, patient in dorsal position. The anesthetic was ether 16 ounces, and was administered for a period of 1 hour and 45 minutes. Patient was unconscious for 4 hours, struggling in first stage no shock. Second day there was consolidation of both bases lasted 25 days. Recovered.

CASE 11 G. H. D., male, age 85 April. Diagnosis: fecal fistula following perforated duodenal ulcer 9 weeks previously. Patient in fair condition. Heart and lungs clear. Resection fecal fistula performed patient in dorsal position. The anesthetic was anesthetic, 3 ounces ether 8 ounces, and was administered for a period of 40 minutes. Operation lasted 50 minutes, and anesthesia was well taken. No struggling good respiration and color normal. Patient made a fair recovery. Developed pneumonia on second day in left lower lobe. Died on the fifth day. White blood corpuscles 6000 on day of death poor reaction. Autopsy: lobar pneumonia, healed ulcer duodenum arteriosclerosis chronic localized peritonitis.

CASE 12 P. N. F. male, age 58 April. Diagnosis: sarcoma of the bladder. Patient had history of pneumonia 5 years previous and much coughing since. Bubbling rales both sides, no dullness, heart normal. Suprapubic cystostomy performed, patient in dorsal position. The anesthetic was gas and oxygen, and was administered for a period of 45 minutes. Operation lasted 40 minutes and patient was unconscious for 1 hour and 10 minutes. Anesthetic was well taken, no struggling, good condition and no postoperative nausea or vomiting. On the second day pulse, temperature, and respiration up. Purulent sputum pain and cough worse, third day process left base (bronchiectasis?) Died in 6 days. No examination of chest. Abdominal incision only.

**CASE 13** S S female, age 44, December. Diagnosis adenoma and cyst of liver. Patient in poor condition. Lungs negative, clear heart normal. Pneumonia 3 weeks previously. Removal of cyst and contents patient in dorsal position. The anesthetic was gas and ether 12 ounces and was administered for a period of 1 hour and 30 minutes. Operation lasted 1 hour and 40 minutes and the patient was unconscious for 3 hours. Pulse poor toward close some shock no vomiting. Three days after operation there was consolidation in right lower lobe. Resolution 10 days. Discharged relieved.

**CASE 14** F St A male, age 70 May. Diagnosis carcinoma of the stomach. Patient in bad condition with cardiac arrhythmia and many râles both sides. Feeble old man. Partial gastrectomy and posterior gastro-enterostomy performed patient in dorsal position. Anesthetic was ether 18 ounces, and was administered for a period of 2 hours and 25 minutes. Operation lasted 2 hours and 35 minutes and patient was unconscious for 6 hours. Anesthetic was well taken, no struggling respiration normal good color fair pulse. Long operation and no evidence of shock. Patient made good recovery. Cardiac condition became gradually worse fourth day pneumonia in right base poor reaction. Died on sixth day. Autopsy lobar pneumonia in right upper lobe arteriosclerosis chronic passive congestion emphysema of lungs operative lesion and cancer of stomach septi caemia (streptococcus).

**CASE 15** J M male age 48 March. Diagnosis recurrent carcinoma of the tongue. Patient had emphysematous chest with few râles. Heart normal. Reaction of tongue performed patient in reversed Trendelenburg position. The anesthetic was ether 16 ounces and was administered for a period of 1 hour and 17 minutes. Operation lasted 50 minutes and patient was unconscious for 1 hour and 5 minutes. Struggling and excitement going under no shock. Patient made good recovery, dirty month could not swallow aspirated food and saliva worse day by day. Temperature gradually rose. Died in one week. Autopsy hypostatic pneumonia purulent bronchitis streptococcus septicaemia.

**CASE 16** M F R. female age 55 March. Diagnosis, pyelitis and pyonephrosis. Patient poorly nourished and old. Heart and lungs clear. Temperature 100 bladder trouble for years, acute for 5 months. Cystoscopy performed patient in lithotomy position. Anesthetic was ether (record missing). Patient ran down hill steadily. On the fourth day developed a cough. Bronchial breathing both bases progressively worse. Died. Autopsy cystitis right ureteritis right pyonephrosis left pyelitis. Lobar pneumonia (bilateral lower) septi caemia.

**CASE 17** D D female age 54 September. Diagnosis cholelithiasis. Patient in fair condition obese. Lungs normal. Systolic whiff and some

arrhythmia. Cholecystectomy and appendectomy performed patient in dorsal position. The anesthetic was ether 18 ounces and was administered for a period of 45 minutes. The operation lasted 40 minutes and the patient was unconscious for 3 hours. No excitement good general condition, rapid operation no hemorrhage. Anesthesia well taken. There was postoperative nausea and vomiting. Patient made good recovery. Developed pneumonia on tenth day from which she seemed to rally. Died suddenly on twenty fourth day. No autopsy.

**CASE 18** J Y male age 60 August. Diagnosis cholecystitis. Patient in good condition. Lungs clear no râles. Lysis of obstructing bands. Anesthetic was novocaine gas 25 oxygen 10 ether 8 ounces and was administered for a period of 1 hour and 18 minutes. Operation lasted for 1 hour and 15 minutes. (Anesthesia report incomplete.) Patient was normal for ten days developed pneumonia on the fourteenth day. Fluid signs 8 ounces of dirty brown bile like fluid with streptococci. Died in 7 days. No autopsy.

**CASE 19** E W male, age 59 July. Diagnosis duodenal ulcer. Patient's lungs normal no râles. Infolding ulcer and posterior gastro-enterostomy performed. Anesthetic was ether 18 ounces and was administered for a period of 1 hour and 55 minutes. Operation lasted 1 hour and 45 minutes and the patient was unconscious for 3 hours and 30 minutes. No struggling pulse normal no mucus general condition normal. Patient normal for 14 days then consolidation of right lower lobe which lasted 10 days and then cleared up. Relieved.

**Bronchopneumonia** This is the most frequent complication we have found in our series and it also falls into fairly definite groups similar to those discussed above under lobar pneumonia. First, there are certain cases in which there was a pneumonia already present at the time of the operation. Case 1 is an example. Case 2 had dyspnoea and râles on entry and in spite of local anesthesia developed a pneumonia which was probably incipient at the time of operation. We feel that Case 3 should be considered separately. Local anesthesia was followed by pneumonia in two days. Our only explanation is hypostasis in a patient 56 years of age although it is possible that some pulmonary pathology was present and overlooked in the pre-operative examination.

In the irritative group the lung condition develops within 1 to 3 days of the administration of the anesthetic. Cases 4 5 6 and 7 are undoubtedly to be placed in this class



Case 4 had had a previous anesthesia shortly before entrance to the hospital and thus combined with the irritation of the foreign body had evidently resulted in a beginning pneumonia which was further developed by the embarrassment of a second etherization. Case 5 was 70 years of age and had a moderately emphysematous lung. Cases 6 and 7 depend more fully on the anesthesia for their etiology. In 6 a profuse secretion of mucus embarrassed the anesthesia while Case 7 though only on the operating table one hour and thirty minutes did not recover for four hours and one half from what must have been an unnecessarily deep anesthesia. Case 9 may equally well be put in this group or classified under the embolic type since there was a septic focus present. Because of the previous anesthetization we consider that it was liable to this complication. Case 10 is especially interesting as the presence of a well defined pneumonia 33 days before operation was noted. Whether there was still some light residual process which the anesthesia lighted up or whether it was simply an irritative type with the localization of the organisms on a previously prepared soil it is difficult to say. At any rate due precautions were taken in this case a wait of nearly five weeks and then spinal anesthesia with a slight amount of anæsthol so that this is truly an unavoidable complication. In this group of 6 cases 4 presented a pre-existing lung pathology (4, 5, 9 and 10) while the remaining cases (6 and 7) we must admit seem to result chiefly from the effects of the anesthesia.

The aspiration of food or mucus serves as the factor responsible for a limited number of bronchopneumonias. Cases 11 and 12 have as their definite cause the aspiration of food and it was necessary to resort to nasal feedings in these cases. Case 8 had a definite bulbar paralysis which opened up the avenue for the aspiration of food and mucus and adds another instance to this group. Thus there were three cases with aspiration as the definite factor in their etiology.

In the embolic group we classify the greatest number of our bronchopneumonias. Some of these cases are part of a general process in which septic emboli lodge in the lungs and

other viscera, causing pyæmia or even general septicæmia yet we include them here because of the difficulty in drawing the lines more closely. Examples of this type are Cases 14 and 15. Case 16 showed râles and dullness in the right back before operation and a subphrenic abscess but it was over a week before the pneumonia developed in the left chest. This may be explained by extension through either the lymphatics or blood stream as in Cases 14 and 15. Case 17 is an undoubted embolus directly following the passage of sounds. Case 18 may also be placed in the embolic group because the pneumonia did not develop until the second week and then only after moving the patient from a closed to a tent ward. The exposure as recently suggested by Boothby (3) may have been an important contributory factor in this case.

Another interesting possibility as a factor in the causation of bronchopneumonia is frequently mentioned in the literature on malignancy. It is claimed that metastases lodge in the lung capillaries and that the inflammatory process thus aroused explains the resulting pneumonia (Keen, 22). If this is so it is possible to account for Cases 19, 20 and 21 of our series. Our pathological sections of the lung were too limited to allow a thorough investigation along this line but in such slides as were available we were unable to locate any malignant tissue.

Case 22 is included here for completeness only for it is secondary to a mediastinitis with extension to the lung tissue and is discussed under that heading.

CASE 1. J. B. male, age 50, May. Diagnosis, inguinal hernia. Patient's lungs had dullness and râles in right side. Radical cure (Bassini) and appendectomy through hernia sac performed patient in dorsal position. The anæsthetic was ether (no record) long operation. Following operation patient temperature up one week. Patches of bronchopneumonia.

CASE 2. E. I. L. female, age 63, January. Diagnosis, umbilical hernia. Patient in fair condition, dyspnoea, numerous râles, very fat, no murmurs in heart. Anæsthetic was local (novocaine 1 per cent). Next day temperature, pulse, and respiration up. White blood-corpuscles increased. Bronchopneumonia both bases. Lived 3 days. No topes.

CASE 3. J. L. male, age 56, August. Diagnosis, inguinal hernia. Patient normal, lungs clear with

slight systolic murmur. Radical cure performed with patient in dorsal position. Local anæsthesia administered. Two days after operation temperature pulse and respiration up. Pneumonia right base. Recovery in 6 days.

CASE 4. F. G. male age 13½ November. Diagnosis: peanut in trachea (several hours duration). Breath sounds modified with many râles and crackles especially in left. Bronchoscopy tracheotomy and extraction performed patient in dorsal position. Ether anæsthetic administered (no record). Dyspnoea day following operation temperature 106°. Two days later bronchial breathing left base. Temperature 105. Small area of dullness. Ten days later much sicker same signs then cleared up rapidly.

CASE 5. H. M. male age 70 October. Diagnosis: duodenal ulcer. Patient old man with emphysema no râles. Infolding and posterior gastro-enterostomy performed patient in dorsal position. The anæsthetic was ether 20 ounces and was administered for a period of 1 hour and 25 minutes. Operation lasted 1 hour and 7 minutes and the patient was unconscious for 4 hours and 25 minutes. The anæsthesia was well taken. Day following operation dullness and râles bronchial breathing and patches which lasted 9 days then cleared.

CASE 6. J. R. male age 20 May. Diagnosis: inguinal hernia right. Patient in good condition lungs normal. Radical cure (Bassini) performed patient in dorsal position. Anæsthetic was ether 14 ounces and was administered for a period of 1 hour and 20 minutes. Operation lasted 1 hour period of unconsciousness doubtful much mucus. On second day patient had patch of pneumonia at right base which lasted 1 week.

CASE 7. L. Z. female age 40 November. Diagnosis: fibromyoma uteri and lacerated perineum. Patient in excellent condition heart and lungs normal. Supravaginal hysterectomy salpingo-oophorectomy and perineorrhaphy performed with patient in Trendelenburg and lithotomy positions. Anæsthetic was gas and ether 12 ounces and was administered for a period of 1 hour and 25 minutes. Operation lasted 1 hour and 15 minutes and the patient was unconscious for 4 hours and 20 minutes. Respiration shallow otherwise normal. Two days later developed pneumonia pain in chest. Pulse temperature and respiration normal in 6 days. Recovery Home on twentieth day.

CASE 8. F. P. male age 38 January. Diagnosis: abscess of brain (?) final diagnosis acute non suppurative myelitis. Patient well developed and nourished. Lungs normal bulbar paralysis. Right subtemporal decompression performed patient in dorsal position. Anæsthetic was ether (record not available). Patient died on following day no lung findings recorded clinically. Autopsy focal pneumonia, left lobe scattered.

CASE 9. E. C. S. female age 3 March. Diagnosis: osteomyelitis radius. Patient in excellent condition. Incision, curettage and drainage per-

formed patient in dorsal position. Anæsthetic was ether (2 operations). Second operation ether 2 ounces was administered for a period of 15 minutes. Operation lasted 15 minutes and the patient was unconscious for 30 minutes. Struggling and excitement pulse 128. After operation patient developed cough. White blood-corpuscles pulse, temperature and respiration elevated patches in left lung normal in 2 weeks.

CASE 10. W. male, age 34 July. Diagnosis: compound fracture of both bones of the leg. Patient on entry had pneumonia in right back. Diagnosed clinically and by X ray waited 33 days for lung condition to subside. Open reduction and bone plate performed patient in dorsal position. Anæsthetic was spinal, stovaine 1.5 cubic centimeters. Anæsthol, 3 ounces administered for a period of 45 minutes. Operation lasted 1 hour. Anæsthesia was well taken. Day following operation temperature 101 pulse 100, respiration 28 to 30. No report in history on condition of lungs. Up in one week.

CASE 11. W. E. male, age 64 January. Diagnosis: carcinoma of the tongue. Patient in good condition with heart and lungs normal no râles. Dissection of neck in first stage partial excision of tongue second stage 25 day interval patient in Trendelenburg position. Anæsthetic was ether 14 ounces and was administered for a period of 1 hour and 15 minutes. Operation lasted 1 hour and 2 minutes patient unconscious for 1 hour and 45 minutes. Patient made good recovery had difficulty in swallowing and was fed by nasal tube. Two days later pain in chest in 3 days dullness in right back. Became gradually weaker and developed cough in 10 days. Fluid and patchy consolidation in right back. Died in 22 days. Autopsy emphysema and bronchopneumonia, right emphysema purulent bronchitis.

CASE 12. L. S. male, age 2 March. Diagnosis: retropharyngeal lymph-glands tuberculosis, and septicæmia. Patient in poor condition labored breathing lungs normal. Tracheotomy performed patient in dorsal position. Anæsthetic was ether (no record). Patient had aspirated feedings. Second day after operation developed dullness and bronchial breathing in right upper lobe. Died. No autopsy.

CASE 13. I. G. female age 11 months April. Diagnosis: deep abscess in neck otitis pyclitis abscess in leg and septicæmia. Patient in poor condition temperature 103 pulse 138 respiration 48 stupor. Patient very sick. Incision and drainage of abscess of neck performed. Anæsthetic was ether (no record). Patient developed within 3 to 4 days a patch at left base which cleared gradually.

CASE 14. A. B. female age 4 months January. Diagnosis: cervical adenitis and emphysema. Patient had eczema all her life. Worse on scalp now than ever. Patient well developed and nourished with heart and lungs normal. Incision and drainage of cervical abscess twice. Anæsthetic local (twice).

Three to four days later developed riles with shifting dullness. X ray sho ed scattered lesions. Died in 3 weeks, 4 hours following a chest tap. Fluid was thick ambe colored. Aut psy confil ent bronchopneumonia, empvema, and septicaemia

CASE 15. C W male age 65 November. Diagnosis hypernephroma. Patient poorly nourished with lungs rmal. Nephrectomy performed, patient in lateral kllow position. Anesthetic was ether (no record). Patient had irregular temperature and pulse n day f low g operatio. no note contin ed irregular. On twenty third day had sudden rise in temperature to 104. Died nt twenty ninth day after operat on riles throughout right chest. A topay septicemia (treptococcus) suppurati e pneumonia chronic pl ritis abscess of right knee arterioscl osis.

CASE 6. F B male age 6 December. Diagnosis, subphrenic abscess. Patient in poor condition. Heart and lungs rmal. Scattering riles and dullness in right back. Incision and drainage performed. Anesth ti was gas and oxygen short operation. Anesth tic was administered for a period of 20 minutes and the operat n lasted 20 minutes. Patient was unconscious for 20 minutes. Patient made fair recovery but no improvement followed. Better f a few days then developed pneumonia on the eighth day in left chest. Died on fifteenth day. Suspicious of right pneum nia all the time. No aut psy.

CASE 17. J M male age 70 November. Diagnosis, stricture urethra. Patient old man with emphysema in good condition. Perineal section performed patient in lithotomy position. Anesthetic was ether (no record). Patient did well for 10 days. sounds passed and on next day patches in left chest. Died in 3 days. No autopsy.

CASE 8. R C male, age 4. Jly. Diagnosis pyelitis. Patient in normal co dition except fo complaint. Temperature 106 respiration 35. Appendectomy with drainage performed. Anesthetic was gas and ether (no record). Patient made good recovery. On fourteenth day (3 days after transfer to tent) had chill. Pneum nia for 1 week then normal.

CASE 19. H C female age 58 November. Diagnosis carcinoma f the breast. Patient in poor condition with riles both sides systolic murmur. Amputation of breast and dissection of axilla performed. Anesthetic was ether 3 ounces and was administered fo a period of 1 hr and 5 minutes. Operation lasted hour and 20 minutes and patient was unconscious for 2 hours and 55 minutes. Small amount f nausea and vomiting on return to consciousness. Patient made a good recovery. In 2 weeks had gradual onset of bronchopneumonia rapidly worse. Died on twenty-sixth day. No aut psy.

CASE 20. C McC male age 60 May. Diagnosis, carcl ma of stomach. Patient in fair conditio obese. X emphysema shady past

history suspicious of chancre. Anterior gastroenterostomy performed. patient in reversed Trendelenberg position. Anesthetic was ether 17 ounces, and was administered for a period of 1 hour. Operation lasted 45 minutes and patient was unconscious for 2 hours and 3 minutes. No postoperative trouble anesthesia well taken. Patient made poor recovery cyanic clammy. In 10 hours, bronchopneum nia at left base, no improvement with stimulati n. Died in 30 hours. No autopsy.

CASE 2. C P male age 45 February. Diagnosis brain tumor. Patient in fair condition with heart and lungs normal. marked cranial pressure total disorientation. Subtemporal decompression, right performed. Anesthetic was ether. No especial shock short operation lasting 1 hour. Patient made no real recovery. Pulse and temperature up at once. Disorientation. Died. Autopsy: hypernephroma bronchopneumonia in right lower lobe perforation of esophagus metastasis of brain.

CASE 1. D O D male, age 30 November. Diagnosis carcinoma of the tongue fully presented under mediastinitis.

*Bronchitis.* In the discussion of this pulmonary complication it must be pointed out that there are undoubtedly many more cases of bronchitis than are here recorded. Often the house officer fails to make a note on a transient condition of this kind and consequently unless it is of a more severe nature it is not properly classified in the hospital records. The cases discussed here had a severe bronchitis in no case clearing up under 6 days. We have divided the group into simple uncomplicated bronchitis and bronchitis complicated by association with other lung pathology. Two cases had pathological processes in the lungs previous to operation, and it seems reasonable to assume that the ether acted as an irritant and assisted in the dissemination of the already present focus.

Case 1 is an example of poor surgical judgment. We feel that the man in this case was exposed to an unnecessary surgical risk in that his condition, duodenal ulcer was not one which demanded immediate surgery and that operation could well have been deferred to a time when the lesion at the right apex was quiescent. Case 5 on the other hand can be placed in the excusable surgical risk class as the gastric carcinoma demanded operation at once, and the lung pathology of necessity was a secondary consideration. The fact that 9 ounces of ether were poured on the cone

for a short operation of 30 minutes points to a factor that might have been better controlled in this case. Case 2 must be put down as an irritative type since on the day following operation his lung pathology was marked and his previous condition was normal. Unfortunately his anæsthesia record was missing so that a complete criticism cannot be made. Cases 3 and 4 however had considerable trouble with the anæsthesia and there was much mucus and difficulty in getting free exchange in the lungs in both cases. Case 3 stopped breathing and artificial respiration became necessary. The amount of mucus mentioned had probably a direct bearing on the etiology in these cases and we think they properly belong in the anæsthesia aspiration class. In Case 3 the trauma of artificial respiration is an additional predisposing factor. It is this type especially in which we feel that a more expert anæsthesia would serve to diminish such complications. Case 6 occurred in a man who was at the outset a very poor risk. He had had a previous transfusion to prepare him for his second operation, and his bronchitis may be regarded as a natural occurrence in a run down individual who has been exposed to long etherization.

Bronchitis in association with other lung pathology is both natural and obvious. There is one case 7 which merits a more complete discussion. To begin with, there was evidence of pre-operative lung pathology at the right base. After a long epigastric operation the patient was in a fair condition for 6 days. At that time there was a rise in temperature, bronchial breathing and profuse expectoration which continued with about the same intensity for one month. A succession of pleuritic rubs, phlebitis in the popliteal region and more friction rubs followed and throughout the next month there were signs in both lungs which were variously interpreted. The medical consultants considered the diagnosis to be probable diffuse capillary bronchitis or at most bronchiectasis on account of the profuse sputum. The X-ray on the other hand showed an area of density in the left upper lobe which was considered to be a possible lung abscess. The subsequent course during which the patient made a

gradual but complete recovery seems to confirm the medical view rather than the roentgen ray findings and we have classified the case as a severe diffuse capillary bronchitis. It is a well known observation nevertheless that a small percentage of lung abscesses heal without surgical interference (Lord 1).

In this group 3 of the 7 cases presented definite pre-operative lung pathology, one was so anæmic that a transfusion was necessary to prepare him for operation, and a fifth case had artificial respiration on the table and an anæsthesia which was very poorly taken throughout. Post-operative pulmonary complications were almost to be expected in these individuals. The effects of anæsthesia may be held responsible for the remaining two cases.

CASE 1. F S male, age 28 September. Diagnosis: duodenal ulcer. Patient slim, dullness in right apex, sibilant râles, diminished breathing in whole right lung. Whispered fremitus is greater in right apex. Pylorectomy and posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was gas and ether 14 ounces and was administered for a period of 1 hour and 25 minutes. Operation lasted 1 hour and 25 minutes and patient was unconscious for 2 hours and 35 minutes. Struggling excited otherwise anæsthesia was well taken. No nausea or vomiting on return to consciousness. Day following operation temperature 101-102, pulse 130, respiration 34. Cough. Recovery in 6 days.

CASE 2. M B male, age 30 August. Diagnosis: cholelithiasis. Patient well developed and nourished, lungs clear, no râles. Anæsthetic was gas and ether (record missing). Day following operation râles, much sputum. Temperature 101 and pulse 90 to 100, descending in 6 days.

CASE 3. H T male, age 52 March. Diagnosis: duodenal ulcer. Patient well developed and nourished, lungs clear, no râles. Infolding ulcer and posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was ether and was administered for a period of 1 hour and 40 minutes. Operation lasted 1 hour and 25 minutes and patient was unconscious for 2 hours. Anæsthesia was poorly taken, stopped breathing at the start, artificial respiration, respiration irregular throughout. Considerable mucus, nausea and vomiting on return to consciousness. Six days after operation temperature 101, respiration 30. Râles all over chest cleared in 2 days. Two day interval then temperature rose to 102, respiration 35, clearing 6 days later. Another attack with sore throat and cough lasted 3 days then normal.

CASE 4. R. C. female age 34. March. Diagnosis, cholecystitis. Patient well developed and nourished with lungs and heart normal no rales. Cholecystectomy performed with patient in dorsal position. Anesthetic was ether 8 ounces and was administered for a period of 45 minutes. Operation lasted 4 minutes and patient was unconscious for 1 hour and 20 minutes. Considerable mucus anasthesia well taken. No vomiting on return of consciousness. Few days after operation bronchitis fairly severe. 8 days later rales in both lungs but no dullness subsided 3 days later.

CASE 5. M. C. male age 48. July. Diagnosis, carcinoma of stomach. Lungs well developed but poorly nourished. Lungs with dullness in left apex. Exploratory laparotomy in supine position. Carcinoma, patient in dorsal position. Anesthetic was ether and was administered for a period of 4 minutes. Operation lasted 3 minutes and patient was unconscious for 1 hour and 40 minutes. Anasthesia was well taken, no vomiting on return of consciousness. Highest temperature for the first 7 days after operation. Note of cause. Note in records. Slight dry cough. Rales mainly at bases in right diminished resonance bronchial catheter. No rales in 6 days leaving patient still had rales in both lungs.

CASE 6. J. M. male age 40. August. Diagnosis, carcinoma of stomach. Operation was for gastric ulcer. Above diagnosis. Malabsorption. The patient was well developed and nourished. Pulmonary normal. Anemia transfused before operation. Gastroenterostomy performed for ulcer lesion. Tumor and posterior gastroenterostomy performed. Patient in dorsal position. Anesthetic was ether 6 ounces. Patient was administered for a period of 1 hour and 3 minutes. Operation lasted 1 hour and 15 minutes and patient was unconscious for 3 hours and 5 minutes. Pulse 100 to 140. 6 hours later normal. No vomiting. Return of consciousness. Day following operation had cough and sputum second day temperature 101° pulse 120 diffuse wheezing bronchitis over entire chest. On fifth day patient was normal again.

#### COMPLICATED TYPE ASSOCIATED WITH OTHER LUNG PATHOLOGY

CASE 7. E. F. B. male age 54. December. Diagnosis, ulcers of stomach and abdomen. Patient fairly well developed and nourished rather thin. Heart normal. Lungs slight dullness behind at right base. Excision ulcer of stomach. Pyloroplasty and posterior gastroenterostomy performed, patient in dorsal position. Anesthetic was ether 4 ounces and was administered for a period of 1 hour and 30 minutes. Operation lasted 4 hours and 45 minutes and patient was unconscious for 4 hours and 5 minutes. General condition good. Fair pulse and low, some mucus no vomiting. Day following operation vomited large amounts of blood. Six days later had tightness of chest bronchial breathing. Temperature pulse 90 respiration

100. KI given much sputum, profuse expectoration and same chest signs for about 1 month, then pleuritic rib of left axilla, followed by phlebitis in left popliteal space. January 6 chest signs cleared. January 6 friction rub right axilla cough sputum through January. Medical consultants probably diffuse capillary bronchitis or bronchiectasis. February 2 X-ray shows area of dullness left upper lobe. Lung abscess too diffuse for operation. February 5 lungs cleared again but cough continued. Gradually chest signs and cough disappeared. Discharged relieved.

CASE 8. J. M. male age 48. March. Diagnosis, recurrent carcinoma of tongue. Resection of tongue performed. Fully presented under lobar pneumonia.

In the pneumonia and bronchitis groups we have tried to demonstrate that in addition to the effects of the anesthetic factors predisposing to lung complications are almost invariably present. We do not mean by this that the anesthetic plays no part in the resulting pulmonary processes for we agree with Kelling (47) that the aspiration of mucus and mouth contents during anesthesia constitutes an important factor in the production of these lesions. We wish to emphasize, however, that this latter factor alone unless augmented by sepsis in the mouth or indifferent administration of the anesthetic is seldom sufficient to cause lung complications. In all but 5 of the 47 cases in these groups, factors were present in addition to the anesthetic.

Pleurisy. Cases of postoperative pleurisy as well as of bronchitis often fail to be recorded and we feel that there must be many others unavailable for this series. Seven cases are reported. We have divided the cases into two classes simple, dry plastic pleurisy and pleurisy complicated in some manner as by effusion or association with other lung conditions. We are inclined to believe that the ordinary dry type is usually the result of an embolic process, a small sterile blood-clot breaking off at the site of operation and finding lodgment in the distal lung capillaries. The associated inflammatory reaction due to infarction leads to friction rub and pain, and the postoperative history seems to bear this out. The onset is as a rule sudden, usually at about the end of the first week or ten days when the patient begins to be more active, the pain and friction

immediate and there is no accompanying fever or leucocytosis. Cases 1, 3, and 4 appear to be definitely of this class. Case 2 had a very evident etiology in a tuberculous lung process which was recognized before operation. Due precautions as to anesthesia were taken in this case but when the nature of the operation is considered it seems to us that it was unnecessary and that the result might have been expected. The medical consultants regarded the postoperative condition to be of tuberculous origin and the association of pleurisy with this etiological factor is so well known as to merit no further discussion.

The one case of pleurisy with effusion has a probable explanation in that the patient had extensive carcinoma with metastases. On the seventeenth day after operation when the patient was up and moving around preparatory to discharge she had sudden pain in the chest, possibly a metastasis and two days later a rapid accumulation of fluid to the level of the right scapula.

Cases 6 and 7 complicated by association with other lung conditions such as pneumonia are clearly only a part of the larger pathological process and have been more fully discussed under the latter classification.

#### UNCOMPLICATED (DRY PLASTIC) TYPE

CASE 1. A. B. female, age 44, November. Diagnosis: cancer of stomach. Patient well developed and nourished with heart and lungs normal. Posterior gastro-enterostomy performed, patient in dorsal position. Anesthetic was gas and ether 12 ounces and was administered for a period of 1 hour and 15 minutes. Operation lasted 1 hour and 15 minutes and the patient was unconscious for 3 hours and 15 minutes. No struggling or excitement, pulse and respiration good during operation. No nausea or vomiting on return to consciousness. Eleven days after operation patient developed pain in right costal margin which was increased by inspiration. Question as to pleurisy cleared up in 4 days.

CASE 2. E. B. female, age 40, January. Diagnosis: dysmenorrhea. Patient had hemiparesis 6 months before admission; on admission had dullness in right chest. X-ray showed old pathological process of right chest which suggests pyogenic process. Dilatation and curettage performed, patient in lithotomy position. Anesthetic was gas and oxygen and was administered for a period of 20 minutes. Operation lasted 15 minutes and the

patient was unconscious for 20 minutes. No struggling or excitement, color fair, general condition normal during operation. Pleurisy probably started before operation and continued. Medical consultant considers it tuberculous.

CASE 3. G. F. female, age 48, February. Diagnosis: fibroids of uterus. Patient well developed and nourished, lungs clear, heart normal. Hysterectomy and appendectomy performed, patient in Trendelenburg position. Anesthetic was ether 17 ounces and was administered for a period of 1 hour and 28 minutes. Operation lasted 1 hour and 18 minutes and patient was unconscious for 3 hours and 20 minutes. Respiration irregular, pulse 120, color fair. No nausea or vomiting on return to consciousness. Seven days after operation patient developed pain in left axilla. Rub was heard next day and lasted for 10 days. It then cleared up.

CASE 4. M. C. female, age 37, March. Diagnosis: extra uterine pregnancy. Patient in poor condition and shallow lungs normal. Salpingo-oophorectomy performed, patient in Trendelenburg position. Anesthetic was ether 5 ounces and was administered for a period of 35 minutes. Operation lasted 25 minutes and patient was unconscious for 1 hour and 45 minutes. Condition poor through out, pulse 130. No nausea or vomiting on return to consciousness. Twelve days after operation patient developed pain in right side, friction rub was well in 3 to 4 days.

#### COMPLICATED TYPE. 1 WITH EFFUSION

CASE 5. A. E. female, age 28, August. Diagnosis: carcinoma of the stomach. Patient poorly developed and nourished, pale, slight dullness at right apex behind, no rales, systolic murmur at apex. Exploratory laparotomy of carcinoma of stomach and liver performed, patient in dorsal position. Anesthetic was ether 12 ounces and was administered for a period of 45 minutes. Operation lasted 45 minutes and the patient was unconscious for 3 hours. Respiration shallow at first, pulse 80 to 98. No nausea or vomiting. Seventeen days after operation patient was up and ready to go home. Developed pain in right chest which became greater on breathing. Temperature 100.2, dullness distant bronchovesicular breathing and diminished voice sounds at right base. Two days later signs of fluid to spine of scapula. Tapped 8 ounces of thick jelly-like fluid obtained. Septicemia (streptococcus). Died five days later. Autopsy: Carcinoma of stomach, extensive metastases to liver, adrenal and lymph glands. Serofibrinous pleuritis, edematous lungs, chronic pleuritis, left streptococcus septicemia.

#### 2 ASSOCIATED WITH OTHER LUNG PATHOLOGY

CASE 6. A. B. female, age 4 months, January. Diagnosis: cervical adenitis. Incision and drainage of cervical abscess performed, patient in dorsal position. Fully presented under bronchopneumonia. Case 14.

CASE 7 J Y male, age 60 August Diagnosis, cholecystitis. Cholecystostomy and lysis of obstructive bands performed, patient in dorsal position. Fully presented under lobar pneumonia, Case 18

**Empyema** Postoperative empyemata are sufficiently common to demand discussion in such a paper. They constitute however a class which we have found rather difficult to place within definite limitations. First being of an embolic nature they fuse into the other complications of lung abscess pulmonary embolism pleurisy and embolic pneumonia. Indeed it is only because the embolus is septic that they differ from certain of the pleurisy cases. Second one must be careful not to classify the terminal empyemata in this group. Thus we have excluded cases developing a postoperative pneumonia with an empyema in the fatal stage. An example of this is the above case 3 more fully discussed under the pneumonias. The other two cases 1 and 2 are definitely uncomplicated empyemata of embolic origin. Both had sepsis present then a sudden attack of pain in the chest with pulmonary signs developing rapidly thereafter. The most probable explanation in these cases is that a small septic thrombus becomes dislodged from the neighborhood of the field operated upon and plugs one of the peripheral lung capillaries close to the pleura. A small abscess forms which breaks through the pleura resulting in empyema. The suddenness of onset forces the opinion that they are embolic and not simple bacterial invasion. It is only because of the bacteria present that empyema and not simple pleurisy results. The mechanism is the same. Case 1 died probably from a combination of evils. The patient was 61 had an insufficiently drained abscess at the site of his bowel perforation and the primary thoracotomy gave only poor drainage. General toxemia resulted, and the necessary second thoracotomy was too much for his already weakened resistance. Case 2 on the other hand, was a strong man of 40 with low-grade sepsis in his legs. His thoracotomy moreover was excellently placed at the bottom of the infected cavity and gave perfect drainage. Recovery became only a question of time.

#### UNCOMPLICATED TYPE

CASE 1 J F male, age 61 October Diagnosis, perforated duodenal ulcer. Patient's heart and lungs normal well developed and nourished 12 hour perforation distention, boardlike abdomen. White blood corpuscles 25 000. Closure of perforation with drainage performed patient in dorsal position. Anesthetic was novocaine, gas and oxygen. Operation was short. Anesthesia was well taken. Patient made excellent recovery but had septic wound. Twenty-six days postoperative pain in left chest. Temperature 103 dullness. Operation for empyema in 33 days. After operation but little improvement. Forty five days later second operation for empyema. Died. Autopsy showed abscess at site of perforation empyema (drained) septicaemia.

CASE 2 T J S male, age 40, March. Diagnosis, varicose veins bilateral. Patient had pneumonia when 28 years old. Ulcers of legs for 15 years. Patient well developed and nourished with heart normal. Lungs rare rale unproductive slight cough for 3 days before operation. Anesthetic was ethyl chloroform and was administered for a period of 1 hour and 45 minutes. Operation lasted 3 hours and patient was unconscious for 4 hours. Anesthesia was well taken cough, nausea, vomiting, and headache on return to consciousness. Patient made good recovery wounds septic. Seventh day developed sudden pain in right chest, prostrated vomited cough in 2 days with rise in pulse temperature and respiration dullness. Right chest tapped pus. Local anesthetic, operation for empyema. Discharged relieved with small sinus.

#### COMPLICATED TYPE ASSOCIATED WITH OTHER LUNG PATHOLOGY

CASE 3 W E male age 64, January Diagnosis, carcinoma of tongue. First dissection of neck and second partial excision of tongue performed at 15 days interval, patient in dorsal position. Fully presented under bronchopneumonia Case 1

**Mediastinitis** Postoperative mediastinitis is another complication which we believe is present in a direct relation to the pre-operative risk (including the location and type of lesion) and to the type of operation performed. Thus we feel that the morbidity statistics are here open to definite improvement. We have defined three chief sources for such infection and with each source the risk is obvious and at times preventable. In operations about the mouth with a dissection of the neck at the same time, in any operation upon the neck, especially in the presence of sepsis, and in instrumentation of the esophagus trachea and bronchi, the danger of a subsequent mediastinitis is considerable

We present three cases all with a fatal termination. They include an example of each of the classes enumerated above and because of the high mortality involved we urge that especial attention be paid to this type of risk. Case 1 with tracheotomy in a case of carcinoma of the larynx we feel is a justifiable calamity. The operation was imperative because of obstruction to breathing so that a consideration of the risks of aspiration or of a descending sepsis need not be discussed. Case 2 was a good pre-operative risk. Here however criticism is justifiable. Death resulted from sepsis traveling down the neck along the planes opened up by the neck dissection. We feel strongly that such cases should be done in two stages. Had this man had his neck dissection first and the open planes given time to heal solidly or vice versa we feel sepsis would not have traveled downward. As it is his death may be justly attributed to an unnecessarily radical operation. Case 3 is an excellent example of the third class with the postoperative complication of mediastinitis. It may still be a mooted question whether the dilatation of cancers of the esophagus is worth while in the presence of the danger of mediastinitis following it, but there can be no question but that lesions definitely diagnosable by the fluoroscope should not be exposed to operative manipulation with the esophagoscope. Such is certainly unjustifiable curiosity and does surgery much harm.

**CASE 1.** A. T. male, age 59 March. Diagnosis carcinoma of larynx. Patient had labored breathing lungs normal. Tracheotomy performed patient in reverse Trendelenberg position. Convalescence prolonged septic wound mediastinitis bronchitis 15 days after operation. Diffuse patches in lungs and died 46 days after operation. No autopsy.

**CASE 2.** D. O. D. male age 50 November. Diagnosis carcinoma of tongue. Patient well developed and nourished lungs clear. Resection of tongue and floor of mouth and dissection of right side of neck, patient in dorsal position. Anesthetic was gas and ether (no record). Day following operation temperature 101-102 pulse 120 respiration 35. Never came down. Died on fourth day. Autopsy phlegmon neck, serofibrous pericarditis, suppurative mediastinitis bronchopneumonia of lower lobe, left lung chronic pleuritis arteriosclerosis septicæmia (*streptococcus mucosus capsulatus*)

**CASE 3.** W. T. male, age 63 April. Diagnosis carcinoma of esophagus and stomach. Patient old, but fairly well developed and nourished arteriosclerosis cachectic heart and lungs normal. Partial resection of carcinoma of esophagus through esophagoscope performed patient in Roser's position. Anesthetic was ether (no record). Next day pain beneath sternum. Temperature 104 respiration and pulse up. Dullness in left base rales behind over whole left lower lobe. Died on third day. Autopsy cancer of stomach involving lower end of esophagus and regional lymph nodes. Perforation of stomach near junction with esophagus phlegmon of peri-esophageal, retropericardial and retropleural tissues.

**Pulmonary embolism.** Pulmonary embolism is correctly called one of the justifiable surgical calamities. It snatches its victims without warning and indiscriminately. No type of operation and no state of pre operative risk is without this danger. We have found in the records for the year studied 6 cases thus classified. In two cases 3 and 4 autopsies were performed and the diagnosis corroborated by the finding of large emboli in the pulmonary arteries. The autopsy on Case 3 was personally observed and a large rider embolus bestrode the bifurcation of the pulmonary vessel practically totally occluding the right and left branches. In Case 4 the finding was much the same.

The time of onset varied from a few hours to 14 days and with the exception of Case 6 onset and death were sudden and almost instantaneous. In the two cases autopsied sepsis was present and drainage free. And in both of these cases the embolism followed unusual activity. Case 3 had just tried his first day out of bed and immediately before death was moved in bed in an effort to make him more comfortable while Case 4 had the dressing changed a rubber tubing drain being replaced by rubber tissue just previous to his sudden collapse. Cases 1 and 5 occurred shortly after operation and could have been due to the sliding away of a fresh thrombus from the operative field. The picture in the latter case is not so clear since the question of mechanical obstruction at the larynx or of interference with the important nervous structures in the neck must enter into our consideration. Case 2 differs from the cases previously discussed in that there was no



sepsis present and that it could not have been a fresh thrombus easily dislodged since it occurred 11 days after operation. It is then to be considered as a case of venous thrombosis in which because of activity an already organized and large thrombus broke loose and brought its inevitable result. Such cases are not unusual and Kelly of Baltimore and Ranzi (5) of Vienna have well discussed the frequency of such calamities in gynecological operations. Case 6 is not so well defined and the correctness of the diagnosis of embolism may be reasonably questioned. Except for his long standing jaundice however this case presented a good risk and the marked dyspnea and cyanosis though of unusual duration may be well taken as evidence of a pulmonary embolus which though not sufficient in size to cause immediate death, either through subsequent thrombosis and aggrandizement or inability of the patient to stand the added strain, terminated fatally. The pulse was weak and rapid and cardiac failure may have been the principal factor but thorough stimulation brought no relief and before operation heart action and the physiological test of his previous active life gained any such subsequent breakdown.

CASE 2. H. B. male age 45 September Diagnosis, carcinoma of the tongue. Patient in excellent condition no illness until present illness well developed and nourished. Lesion of tongue for 3 months heart and lungs clear no murmurs no rales. Radical operation one stage dissection of left side of neck division jaw removal of tumor and tongue en masse bone plate to jaw patient in dorsal position. Anesthetic was gas and ether 3 ounces, and was administered for a period of 1 hour and 50 minutes. Operation lasted 2 hours and 3 minutes and patient was unconscious for 3 hours and 35 minutes. Anesthesia was well taken good color pulse 120 no struggling excitement. Patient made excellent recovery. At midnight was normal and slept in naps until 4 a.m. Soon after became a little restless, sat up in bed suddenly sank back and died in a few seconds. No observations of respiratory difficulty. No autopsy.

CASE 3. M. C. F. female age 54, October. Diagnosis, proclivita uteri. Patient obese old woman womb trouble for 7 years. Heart and lungs clear no murmurs sounds distant pulse 110 no rales. Amputation cervix, anterior and posterior colporrhaphy and ventral fixation performed patient in lithotomy and Trendelenburg positions.

Anesthetic was novocaine and ether, 9 ounces, and was administered for a period of 2 hours. Operation lasted 1 hour and patient was unconscious for 2 hours and 30 minutes. Anesthesia was well taken pulse 88 to 100 good color. No postoperative nausea, vomiting or cough. Patient made good recovery. On tenth day wound clean and solid. On eleventh day suddenly fell back very dyspneic and died in a few minutes. No autopsy.

CASE 3. F. A. A. male, age 43 January. Diagnosis, pyelitis with abscess. Patient had one previous attack present attack of 12 hours' duration. Patient well developed and nourished but gray look local tenderness and spasm. Heart sounds normal lungs clear. Appendectomy for retrocecal appendix performed necessary to mobilize cecum free drainage patient in dorsal position. Anesthetic was ether 30 ounces, and was administered for a period of 1 hour and 40 minutes. Operation lasted 1 hour and 30 minutes, and patient was unconscious for 3 hours and 50 minutes. Considerable struggling and excitement general condition poor long hard operation pulse 120. Postoperative nausea, vomiting cough and hiccough. Patient made fair recovery. Had vomiting and hiccoughing and distention for 8 days. Stormy convalescence which cleared up. On fourteenth day sitting up subjectively fine. Pulse, temperature and respiration rose a little. On seventeenth day comfortable at 6:30 p.m. at 7:30 p.m. dizzy spell, heart action weak and irregular restless, some improvement. At 8:50 p.m. died suddenly without marked pulmonary distress. Autopsy pulmonary embolism and thrombosis with plugging at bifurcation pulmonary vessels. Pelvic abscess, localized septicemia (streptococcus), dilated heart.

CASE 4. H. G. M. male age 7 May. Diagnosis, tuberculosis of kidney. Patient's general condition good. No loss of weight present trouble one year. Patient well developed and nourished heart normal abdomen negative no c.v.t. lungs clear no rales or rubs. Left nephrectomy with drainage performed patient in lateral position. Anesthetic was gas 80 oxygen 20 and ether small amount, and was administered for a period of 1 hour. Operation lasted 1 hour and patient was unconscious for 1 hour and 15 minutes. Anesthesia was well taken and general condition normal. No struggling no vomiting. There was some postoperative nausea. Patient made good recovery. Temperature pulse and respiration slightly elevated, drained well. Condition improved after eighth day. Draining tenth day at 8:50 p.m. rubber tube taken out and replaced by rubber tissue drain which was followed by headache and nausea. At 10:15 p.m. was dizzy and faint position changed, fainted twice rallied, rational. Respiration became dyspneic pulse 94 of fair quality. Respiration and pulse suddenly ceased. Autopsy pulmonary embolism streptococcus septicemia.

CASE 5. M. M. female, age 53 July. Diagnosis, deep cervical adenitis. Patient for 4 days had

swelling in throat with dyspnoea was well developed and nourished. Lungs and heart clear temperature 100 mass under ramus jaw on right side.

(1) Incision and drainage for cervical adenitis and (2) tracheotomy for oedema glottis patient in dorsal position. Anaesthetic was anaesthol (no record) After first operation patient in poor shape dyspnoea marked. Tracheotomy performed with great relief at 12.45 a.m. Comfortable at 1.45 a.m. and normal at 1.50 a.m. respiration dropped to 5 also marked failing in character of pulse. No dyspnoea. Died suddenly No autopsies.

CASE 6 J T male, age 71 May Diagnosis carcinoma of bile ducts Patient in normal condition until present illness Painless jaundice for 1 month Patient well developed and nourished lungs clear above squeaks and rales at bases Systolic murmur at apex of heart moderate arteriosclerosis Cholecystectomy and choledochostomy performed patient in dorsal position Anaesthetic was ether 16 ounces and was administered for a period of 1 hour and 50 minutes Operation lasted 1 hour and 15 minutes patient unconscious for 4 hours and 45 minutes. Had jerky respiration pulse 100 to 120 general condition fair no vomiting Patient made good recovery and was normal for 24 hours On third day temperature went down and pulse up 100 At 6 p.m. pulse rapidly began to fall weak and rapid dyspnoea and cyanosis marked stimulation if no avail. Died before midnight Went to pieces rapidly but not suddenly No autopsy

**Pneumothorax** The postoperative complication of pneumothorax admits of little discussion since its etiology is definitely mechanical and hence obvious Operations close to the attachments of the diaphragm always offer this possibility and necessarily operations on the kidney give us the greater percentage of such complication (Quimby 53) We would like to point out however that in this discussion we have not included pneumothorax following operation on the lungs as such a result is practically always to be expected However it is rarely a fatal complication in this latter class although in the past year one of the deaths following thoracotomy for lung abscess was probably due to this complication. Both cases in our series were the result of operations for the removal of a kidney and both recovered Unless sepsis is present or the immediate shock too great, we feel the prognosis is good without treatment Quimby (53) advocates immediate closure of the tear with support of the mediastinum by forceps if the collapse and

symptoms are marked and aspiration of the pleural cavity after operation.

CASE 1 S S female, age 22 February Diagnosis infected hydronephrosis. Patient in good condition with lungs normal. Nephrectomy left (small hole torn in pleura, immediate closure) performed with patient in lateral kidney position. Anaesthesia was gas 300 oxygen 70 and ether 4 ounces and was administered for a period of 1 hour and 5 minutes. Operation lasted 1 hour and patient was unconscious for 2 hours Anaesthesia was well taken slight nausea on return to consciousness. Some shortness of breath next day absence of breath sounds left side hyperresonant Roentgenogram showed left lung collapsed. Aspiration following day signs nearly same as before aspiration. Gradually cleared up

CASE 2 A S male age 28 April Diagnosis hypernephroma. Patient well developed and nourished with chest normal good risk. Nephrectomy right, twelfth rib resected pleura opened during maneuver and closed immediately patient in lateral position. Anaesthetic was ether 16 ounces and was administered for 1 hour and 30 minutes Operation lasted 1 hour and 6 minutes and patient was unconscious for 3 hours and 30 minutes Mucus and vomiting during operation. Five days after operation temperature 100 pulse 100 respiration 30 Night of sixth day sudden severe attack of dyspnoea temperature 101.2 pulse 120 respiration 34. Next day temperature and pulse came down recovery excellent no treatment for pneumothorax necessary

**Lung abscess** In our studies no well defined case of postoperative lung abscess was found Unquestionably some of the empyema cases occurring after operation begin in a small abscess embolic in origin, at the periphery of the lung but the picture of empyema is the more prominent and cure results in the treatment of this condition One case 7 in the postoperative bronchitis class was possibly a real abscess but it was never definitely proved so Lord (1) however has remarked that a certain proportion of the lung abscess cases do heal without operation. So the final cure in this case is no definite proof against the diagnosis of abscess Pine (6) in a recent article has shown how valuable X ray findings are in the diagnosis of lung abscess and it is our opinion also that this diagnostic method is of the greatest importance Therefore we hesitate to be arbitrary in the classification of the above mentioned case That it stands alone is an argument pointing to the relative in

frequency of the condition in general surgery. Lord (1) has found that in operations confined to the nose and throat the incidence of lung abscess is high. In his series 10 per cent of the cases of lung abscess followed operations in this field.

#### EMPHYSEMA AND LUNG ABSCESS

In our analysis we have deliberately avoided classifying in this study the postoperative pulmonary complications of emphysema and lung abscess since it is apparent that the incidence of some further pulmonary lesion will reach 100 per cent. By removing these groups we feel that we present a more accurate picture of the postoperative complications of general surgery which we have under discussion. To justify this stand we offer a short summary of each of these groups as they occurred in the year work under analysis.

There were 23 cases of emphysema operated upon with 4 deaths a mortality of 17 per cent. In over 90 per cent of these cases pneumonia preceded the emphysema and in a large proportion it had not entirely subsided at the time of operation. Cardiac failure in the table was charged with the responsibility in three of these four fatalities, and it is best explained by the too rapid change in intrathoracic pressure allowing a dilated heart to become more fully embarrassed. The fourth case died of prolonged sepsis following peritonitis. Pulmonary complications were present in every instance, always pneumothorax frequently bronchitis and often a residual pneumonia. A further factor, imperfect drainage, made a second operation necessary in three cases. A distressing complication encountered in a certain number of cases was the fact that a persisting sinus remained at the time of discharge from the hospital and it is this type which probably constitutes the large class of chronic emphysema cases that infest the outpatient clinics of every large hospital. We feel that the chief factor responsible for this condition is the failure to establish drainage at the most dependent portion of the infected cavity.

There were 11 operations for lung abscess. In every case there was at least a transient

bronchitis and four cases ended fatally. Two were followed by empyema, one by pneumothorax, one by hemorrhage and three terminated by cardiac failure. The technique of operation was the same in every case. First a preliminary thoracotomy under anasthetol anesthesia with an attempt to promote pleuritic adhesions either by suture or a gauze pack. After a suitable interval secondary exploration of the lung was done with the hope that the first operation had excluded the general pleural cavity and that drainage might be established through a previously prepared opening. The difficulties of this surgical problem are emphasized by the resulting complication of pneumothorax and empyema in spite of the preliminary care taken to avoid these sequelae.

To include such groups under the postoperative complication of general surgery would seem hardly fair and might give a false impression of the dangers and risks involved.

#### COMPARISON WITH STATISTICS FROM OTHER CLINICS

In making comparisons it is desirable to get statistics from clinics which fulfill the same general requirements as our own if possible. We have found this to be especially difficult on account of the diversity of our surgical pathology and because of the fact that our active emergency service brings us all kinds and conditions of men and surgical risks. To compare our figures with those from the Mayo Clinic (7, 8 and 9) would seem inconclusive and unfair to the quality of our work for we feel that in Rochester there is an entirely different clientele. This in part may explain the discrepancies between the morbidity and mortality reports from such institutions and our own. It is easy to see how in a clinic such as that at Rochester where there is a minimum of septic and emergency work and where a previous train ride often of days has tested out the pre-operative risk to a considerable extent there should be a decidedly lower mortality result. And again we have also to remember that the surgery in a general hospital such as the Massachusetts General is not confined to a small group of operators but that many surgeons and much

variety in preparation and technique contribute to the final statistics in such an institution. Consequently we feel that reports from the large general hospitals in the big cities are much more valuable in giving us a picture of the pulmonary complications that are liable to arise in general surgery.

We have gathered together such summaries of the pulmonary complications following general surgery as we have encountered and present them in chart form.

#### GENERAL SURGERY—ALL LUNG COMPLICATIONS

Reference	Number of Cases	Pulmonary Mortality	Morbidity Per Cent	Mortality	Mortality Per Cent	Morbidity Per Cent of Mortality
Mayo* (Beckman, 7)	2657	4		0	4	0
Mayo* (Beckman, 8)	2835		57			63
Mayo* (Beckman, 9)	2835	87			100	
V. Lichtenberg (Ranzi 5)	687	203	28.7	1	1	1
Montreal General Hospital (Armstrong)	300	55		3	15	15
Massachusetts General Hospital (E. C. C. and Mayo)	3400	65	2.5	23	24	80.7
Omassebeck (Otte, 11)	7 years total cases 3000+		1	1	1	1
Pfannenstiel, 20			1	1	1	1
Combined Statistics (Lichtenberg, 1)	1674	44	9			

\*Amended to include pulmonary embolism.

†Not recorded for whole series.

‡N lung complications.

§N deaths from lung complications. N pneumonia.

It is noted that in the large general city clinics the incidence of lung complications varies from 1.8 to 3.8 per cent. But it is the mortality figures that are most interesting. Unfortunately Ranzi (5) did not present his mortality statistics so that we cannot use his report for comparison but the Montreal General Hospital shows a very similar figure to the mortality percentage of morbidity in our own summary. It is the pneumonias and the embolism cases that contribute most largely to the deaths.

In contrast to the figures of Ranzi (5) Armstrong (10) and ourselves are those presented by Beckman (7, 8 and 9) Pfannenstiel (20) and Otte (11). At the Mayo Clinic, although they were unable to prevent altogether the incidence of pulmonary complica-

tions they were fortunate in that they had an extremely low mortality from this score. Pfannenstiel (20) and Otte (11) were successful in abolishing the pulmonary complications entirely a truly remarkable record. There are many factors that help explain their excellent results—very careful selection of cases, good risks, careful preparation, careful anesthetics by the same trained anesthesiologists, operations by the same group of surgeons etc. These men deserve commendation for the prophylactic measures taken against the lung sequelae.

The Mayo Clinic figures have been slightly changed by us to include pulmonary embolism under the pulmonary complication figures in order to compare with the reports of the other clinics. The incidence of pulmonary complications has been in an almost constant ratio to the number of cases in the Mayo Clinic but the mortality figures in those cases developing pulmonary complications have shown a marked improvement from 21.9 per cent in 1910 to 0.0 per cent in 1913. The factors responsible for this change are not cited but would be of undoubted value to others in the solution of this problem.

Total figures including those of von Lichtenberg give 52,851 cases, 1043 of which developed a postoperative pulmonary complication (1.9 per cent). This means that in every 50 cases operated upon, one will develop a lung complication. These figures may not appear so serious until the mortality statistics are consulted. Here we find grounds to make any surgeon hesitate for postoperative pulmonary conditions invariably have a higher mortality than in these diseases when uncomplicated by surgery. Thus in our clinic 50.7 per cent of those developing lung complications died, i.e. in every 106 cases operated upon one died from such a lesion.

In contrast to the limited number of reports on general pulmonary complications the literature abounds with articles on postoperative pneumonia. The accompanying chart—General Surgery Postoperative Pneumonia—comprises the statistics on this score from some of the large clinics in this country and in Europe.

# GENERAL SURGERY — POSTOPERATIVE PNEUMONIA

Reference	No. of Cases	Pneumonia Mortality	Mortality Per Cent	Mortality	Mortality Per Cent	Mortality Per Cent of Total
Mayo (Rochester, 7)	2617		17	1	14	30.5
Mayo (Rochester, 8)	64		30		68	
Mayo (Rochester, 9)	14	1		7	50	30
Roosevelt Hospital, N. Y. (L. S. B. 1)		1	66	7	30	46.6
N. Y. Hospital, (F. W. B.)						
Massachusetts General Hospital (E. C. C. and J. M.)	1490	40			63	5
Mayo Clinic General Hospital (Armstrong, 1)	800	10	20	23	28	6
Leipzig (Lawrence, 14)		30	8		5	
Pennsylvania Hospital, N. Y. (A. O. W.)	208					
Excluding Presbyterian Hospital N. Y.	430	150	64			
	95					
Total	24	14	28		30	59.0
Oxler and McCrae	10	120				

With the exception of the Mayo Clinic reports which are unusually low the average hospital surgery is complicated by postoperative pneumonia in approximately 1.5 per cent of the cases operated upon, and even including the statistics from the Rochester clinic about 1.0 per cent develop pneumonia. This factor alone is likewise responsible for 0.5 per cent of the total average mortality of any large surgical clinic. Of the patients who develop this complication somewhat over 50 per cent will be unable to combat the added burden successfully. This is the probable reason for the attention that has been given to pneumonia as a complication of general surgery. The sources of Oxler and McCrae's statistics were not available and we present them merely as additional evidence of the incidence of postoperative pneumonia. Their figures correspond most closely with those from the Mayo Clinic and are relatively low.

When it is further considered that the majority of the postoperative pneumonias probably belong to the Group IV type of organism as reported by Whipple (15) it seems that the general condition of these patients must be a deciding factor because the usual Group IV organism is of relatively low virulence (Dochez and Cole 16) and would not of itself account for more than 50 per cent of the total number of fatalities. Compared with

the average mortality for pneumonia, these figures are almost double in fact they correspond more accurately with the figures for the mortality of this disease in the physically infirm which is estimated at 53 per cent (Oxler and McCrae 17).

Pulmonary embolism has received a considerable share of attention because of the ruthless way in which it strikes down apparently favorably convalescing individuals. Wilson (46) has collected the Mayo Clinic statistics covering a period of 22 years in an endeavor to throw some light on this obscure subject. He shows that in every 1352 operations embolism is to be expected once a percentage of 0.07. The factors considered responsible for the etiology are injury to the vascular walls allowing and stagnation of the blood stream, disintegration of the blood corpuscles from toxic substances, and bacteremia. In order to combat these conditions he suggests the reduction of vascular traumatism to a minimum, early free movement on part of the patient, and measures to reduce bacteremia, i.e. destruction of local foci of infection with canterly and preliminary vaccine treatment when the invading organism can be isolated. Kelly of Baltimore had previously called attention to the possibility of trauma to the large vessels in the etiology of this complication. Ranzi (5) in his report from von Eiselsberg's clinic, Vienna, treats embolism in a more sweeping manner including under the term not only true pulmonary embolism but also the embolic lung infarctions and the purulent processes lung abscess and empyema, arising from small septic emboli. We have taken up these latter under a different grouping so that only the first portion of his report, viz. true pulmonary embolism cases need be considered in this comparison. Fatal embolism with plugs demonstrable in the pulmonary arteries or large branches occurred 23 times out of 6871 operations, a proportion of once to every 299 cases, or 0.33 per cent. This is a much more frequent occurrence than in the Rochester clinic. Our figures represent practically the mean between these two groups, 6 cases in 3490, or once in every 581 operations, a percentage of 0.17. The average for the

three clinics shows that once in every 744 operations we can expect such a fatality for the mortality in this complication is 100 per cent.

Pleurisy of the dry type is recorded from the Mayo Clinic 13 times in 1910 (7) 22 times in 1912 (8) and 18 times in 1913 (9). It has been uniformly of a mild nature and but for the disagreeable subjective symptoms which lasted as a rule only three or four days has caused little trouble. Two cases of pleurisy with effusion were reported for the year 1910 (7) with one fatality and no similar cases are mentioned in the 1912 or 1913 statistics. In 13 or 13 cases operated upon at the Presbyterian Hospital New York, Burnham (18) found dry pleurisy following operation in 45 cases and pleurisy with effusion (serous) 14 times 4.53 per cent. In contrast to the dry type which is not usually accompanied by a general reaction, the pleurisies with effusion practically always have a fever ranging from 100.8 to 104 and a moderate leucocytosis. The prognosis is also fairly good for this type. Burnham lost one of his 14 cases. The treatment which he recommends is aspiration of the fluid and injection of 2 per cent formaldehyde in glycerine if the culture of the fluid shows bacteria present. Effusion is most frequent following acute abdominal conditions associated with peritonitis according to this observer. Bibergeil (19) in 3909 laparotomies had 16 cases of pleurisy with effusion, or 10 per cent of all his respiratory complications. In the Massachusetts General Hospital, pleurisy with effusion has been relatively infrequent, but one case occurring during the year reported. This case terminated fatally. There were in addition four cases of dry pleurisy which ran an uneventful course.

Empyema, on the other hand is a very serious complication, and is accompanied by a high mortality. Burnham (18) in reference to this point emphasizes the bad prognosis and shows that in his six cases there was not a single recovery. All of his cases followed laparotomies and in each the lesion was associated with peritonitis either local or general. The diagnosis of empyema (post operative) in these cases might be easily over-

looked until the process had become advanced, because aside from the temperature chart there were no symptoms or signs to point to the existence of the condition. The absence of pain, cough or symptoms referable to the chest should be especially noted. Burnham concludes that a turbid or purulent effusion in the chest following laparotomy requires immediate drainage and should lead at once to exploration of the subphrenic space because of the frequent association of these two conditions. Bibergeil (19) in his 3909 laparotomies had 13 cases of empyema, with no mortality figures given. We were fortunate in having only two cases of postoperative empyema one of these made an excellent recovery after a well placed thoracotomy operation and the other case died. The latter case falls into the category described by Burnham since there was present a localized peritonitis.

Bronchitis following operation is such a transient and non fatal complication that there are very few available reports on this condition. The Mayos had 12 cases in 1910 (7) 39 in 1912 (8) and 18 in 1913 (9). None of these resulted fatally. We found 6 cases with no fatality.

Numerous observers have noted that pulmonary complications and especially pneumonias are more prone to follow laparotomies than operations elsewhere so that a large bibliography has arisen around this point. The reports on pneumonia following abdominal operations are gathered together here in chart form.

LAPAROTOMIES—PNEUMONIAS (POST OPERATIVE)

Reference	Number Cases	Mortality	Mortality Per Cent
Zurich (Kronlein, )	400	8	2.0
Massachusetts General Hospital (E. C. G. and J. J. M.)	8	90	1.7
Breslau (Quain, 44)	85	48	3.4
Hamburg (Kronlein, 45)	1754	42	3.5
Berlin (Bibergeil, 9)	3900	35	3.0
Heidelberg (Lewy, 46)	300	5	1.5
Leipzig (Lewy, 47)	150	95	1.4
Munich (Gabel, 4)	90	77	0.43
Breslau (Ottle, 30)	147	143	2
Koenigsberg (Vold, 48)	071		1.5
Average mortality			4.7

From this chart one can see that the average figure 0.95 per cent for postoperative pneumonia in general surgical conditions is increased five times when abdominal surgery alone is taken into consideration. Why should such an increased incidence exist? To explain this we believe there are many factors concerned. First the abdominal group of operations represents a large percentage of emergency surgery oftentimes accompanied by septic processes. The consequent exposure in the preparation of the patient and in the operation itself is much greater and the general pre-operative risk is not so good as in the other groups of conditions. Our figures for this group are proportionally low. This surprises us for our clinical observations had led us to the impression that following laparotomy we had a high percentage of pulmonary complications. Analysis of our statistics shows that it is the epigastric operations in which the high percentage of complications occurs. A large number of our laparotomies are explorations of the pelvis for gynecological conditions and we feel that this field offers less danger from such complications. The statistics from gynecological clinics bear this out. Otte (11) reports no pneumonias from the Osnabrueck clinic covering observations during 7 years while Robb and Dittick (30) had 6 pneumonias in 1007 cases only 0.58 per cent.

Kelling (47) and Bibergeil (19) in a careful study of the factors concerned in the production of pneumonia following laparotomy conclude that other than the general factors (age, anaesthesia, vasomotor influences, pain, etc.) there is present the possibility of extension of abdominal sepsis through the numerous pathways of the blood and lymphatic systems. These observers lay the greatest stress on the presence of sepsis either as a pre-existing lesion or inoculated at the time of operation. Their observations are further supported by the studies of Gerulanos (52) who records the extremely high incidence of pneumonia in the pre-antiseptic days.

It is the surgery of the epigastrium however that offers the field par excellence for the development of postoperative pulmonary complications. We have carefully summar-

ized our operations in this region and find that in 295 epigastric incisions for operations on the stomach, gall bladder, pancreas, etc. 23 have been followed by pulmonary complications a percentage of 7.7. Eleven of these 23 patients died giving a mortality of 37 per cent from lung complications and 47.8 per cent of the pulmonary morbidity in this group. We have been puzzled by this marked incidence because it is in this field that our most experienced surgeons operate and also where the most careful precautions are taken before and after operation. There seems to be a number of factors which may be in part responsible for the postoperative pulmonary sequelae in this field. First conditions are almost ideal to produce hypostatic congestion of the lower lobes of the lung. This is brought about by imperfect expansion of the lower chest due (1) to a painful wound which leads the patient to splint the part, and (2) to a tight swathe used to hold on the dressings. Add to this the long exposure and chilling of the diaphragm and the trauma by retractors and gauze and further still the possibilities of vasomotor disturbances by injury to the vagus or sympathetic control and it is easy to see that congestion of the bases is bound to result. Armstrong (10), Bibergeil (19) and Kelling (47) have laid especial stress on the part played by chilling of the diaphragm in epigastric operations. They advocate the careful walling-off of the subdiaphragmatic space with hot wet packs to combat this sequel. The easy pathways of infection through the diaphragm by blood or lymphatic channels (Kelling 47) (Sabin, 48) will allow extension to this perfectly prepared field even if the pulmonary organisms have not already taken advantage of the situation. Gee and Horder (49) state. From the concurrence of perigastric adhesions and adherent pleura over the diaphragm in the post-mortem room it is probable that the pleura not seldom becomes infected in gastric diseases without perforation of the stomach. The high morbidity percentages with epigastric incisions is thoroughly discussed in the literature. Bibergeil (19) reports 5.8 per cent pneumonias and Laewen (40) 8.1 per cent total lung complications. Our own statistics show

figures midway between these two and in striking contrast to the 11 per cent average morbidity following general surgical conditions. A contributing factor to those already mentioned may be the method of preparation which usually leaves a patient wet on the table throughout his one to two-hour operation as the case may be.

#### GENERAL DISCUSSION AND SUMMARY

The field presented is so broad and diversified that it is difficult to confine any discussion within moderate bounds. Certain facts however stand out sharply both as shown by our own statistics and in the comparison with the reports from other clinics. One is struck at once by the very considerable percentage of lung complications in some clinics ranging as high as 38 per cent (Ranzi 5) and 22 per cent (Armstrong 10) and again by the relative freedom from such sequelae in other clinics (Beckman, 7 8 9) (Otte 11) (Pfannenstiel, 20) (Kroenlein 21). There must be some explanation for this discrepancy in addition to the argument that the type of patient varies greatly as to pre-operative risk in the different clinics. In large hospitals such a wide variation is not probable. Furthermore in the above mentioned reports where the percentage of complications was low sensible and adequate explanation and reasons are presented to justify their low postoperative pulmonary morbidity. Thus Otte (11) Pfannenstiel (20) and Kroenlein (21) observed exceptional precautions before, during and after operations. The mouths of patients were carefully cleansed with antiseptic solution before operations expert anesthetists were employed regularly the preparation on the table was short and such as not to unduly expose the patient to cooling fluids the operation was begun as soon as possible and the most careful precautions were observed after operation to avoid any exposure to draughts or cold air both on the way to the wards from the operating rooms and later in the recovery wards. Furthermore the steady improvement in the Mayo Clinic statistics as reported in the years 1910 1912 and 1913 can be taken in part as an indication of the increased efficiency

of anesthesia and postoperative precautions in that clinic. The discharge of patients before the convalescence is completed renders their figures less valuable in any comparative study of statistics. In the clinics reporting high postoperative pulmonary morbidity there is no evidence of any such exceptional precautions nor can we say they have been in use in this hospital.

From reading reports it is impossible to conclude which factor is the more important and great stress is not laid on the same factor by any two writers. Thus one cannot say with any certainty that by improving the method of giving anesthesia complications may be avoided though this is the chief factor usually discussed. If it were true that by improving the method and technique of anesthetization postoperative pulmonary complications could be entirely avoided then one might truly declare that there is such a thing as ether pneumonia i.e. a pneumonia directly dependent on the irritation of the anesthetic. Our personal feeling is that it rarely exists as a definite entity. Exposure during or after operation, pre-existing lung pathology or small emboli, are added factors which are usually present and whose importance should not be underestimated. Factors of this kind in addition to the irritation of the anesthetic were present in 37 of the 40 pneumonia cases in our series.

In the clinic of the Peter Bent Brigham Hospital Boston a rather alarming number of postoperative pneumonias occurred a year ago. Since then the method of anesthetization has been the same but exceptional measures for avoiding postoperative exposure have been observed and all patients recover in warm rooms adjoining the operating rooms under constant observation by competent nurses. During this latter period but one postoperative pneumonia has been recorded (3). Armstrong (10) Kelling (47) Homans (2) Gerulanos (52) and Keen (22) insist on the dangers from excessive cooling of the body while under an anesthetic, and Harmer (25) has demonstrated that chilling by cold solutions and alcohol as used in pre-operative preparations is injurious. In addition it is the impression of the Mayo brothers and their



colleagues (Beckman, 8) of Kelling (47) of Armstrong (10) and of Henderson (23) Magaw (24) Keen (22) and many others that a true ether pneumonia does not exist as a definite entity. In their minds as in ours the aspiration of vomitus or mucus the presence of pre-existing lung pathology or oral sepsis or subsequent septic emboli are more often real factors in this etiology Hoelscher (26) and Kelly (27) have demonstrated experimentally the constant aspiration of mucus from the mouth during anaesthetization. Thus they emphasize the value of thoroughly cleansing the mouth and removing necrotic teeth and septic roots a precaution insisted upon by Otte (11) Pfannenstiel (20) and others whose reports of the postoperative pulmonary complications are striking because of their almost total freedom from such sequelae. Further the high percentage of pulmonary complications following local anaesthesia (Gottstein 28) (Henle 29) is another argument against the rôle of the anaesthetic in the etiology of such conditions although it must be admitted that probably the patients in whom this type of anaesthesia was used were more often the aged and bad risk cases. Yet Gottstein (28) and Mikulicz (30) report larger percentages of pneumonias after local anaesthesia than after general anaesthesia. Of our 65 cases with pulmonary complications 4 were operated under local anaesthesia and 3 of these developed broncho-pneumonia.

We are therefore inclined to doubt the existence of a true anaesthetic pneumonia. At the same time we do not intend to convey the idea that the anaesthetic plays no rôle in the production of such complications. On the contrary we are certain of its very real dangers and would urge most strongly constant efforts to perfect the technique of its administration. It is not our purpose to discuss here in detail the comparative values of the cone and drop method of giving ether but what has long been held that, by using the cone warm ether is inhaled, thus lessening the danger of postoperative pulmonary complications in our experience is proved untrue. As to the gas-ether sequence our observations lead us rather to discredit this method

since we have both observed frequently much and alarming cyanosis with the change from one anaesthetic to the other. It may be true that the technique of performing this change is not perfected in this institution and that concentrated ether is forced suddenly on an already cyanosed and struggling patient, but it is our opinion that the time gained is not commensurate with the risk. Not only is an increased burden suddenly placed upon the heart and intense irritation of the lungs brought about, but there must be a very considerable stimulation to the production of mucus which has been shown both experimentally and clinically to be an important factor in the causation of postoperative lung conditions. The argument that gas is far more agreeable to the patient still may hold good but we feel that ether given carefully and slowly by the drop method is not necessarily disagreeable (Keen, 22). In fact we would point out that it is generally with patients who have previously been anaesthetized with ether by the cone method that we find any such deep rooted dislike toward this drug.

Poppert (31) has shown experimentally the dangers of a too concentrated ether vapor and Hoelscher (26) has demonstrated the dangers of the inhalation of mucus while under an anaesthetic. Further experimental evidence Offergeld (32) Poppert (31) von Lichtenberg (33) Ladd and Osgood (36) stamp the open-drop method as the far safer course and Magaw (24) Boothby Bevan (34 35) Kroenlein (21) Keen (22) Herb (4) etc. confirm this method from clinical observation and experience. Gatch (50) well summarizes the experimental results dealing with the effects of ether vapor upon the lungs as follows. The irritant action of ether vapor varies with its concentration postoperative lung complications are frequently caused by the aspiration of mouth contents. The greater severity of the pulmonary lesions found after experimental etherizations by the closed method can be satisfactorily accounted for by the great concentration of ether vapor in the closed masks and the greater liability to aspirate mouth contents when these are used. A more recent article by Herb (4) confirms

these findings from clinical observation and experience and in addition denies the advantages of warm ether vapor an advantage claimed for the cone method

Otte (11) Pfannenstiel (20) and Kroenlein (21) show excellent figures when anesthesia has been carefully administered and such experienced anesthetists as Henderson (23) and Magaw (24) state the rarity of pulmonary complications when the anesthetic is in skilled hands Armstrong (10) after studying his statistics places the greatest importance on a skilled anesthetist as one of the chief factors in preventing these complications The evidence therefore is overwhelming that the anesthetic if poorly administered may be to some extent to blame Keen (22) Gwathmey (37) Boothby Bevan (34 35) Henderson (23) and Magaw (24) all insist on the greater safety of ether over other anesthetics so that we consider that the discussion of other anesthetics in this paper is unnecessary We feel however that it is only fair to state that a large proportion of the German statistics which we have reviewed come from clinics where chloroform narcosis was employed

Throughout this study we have been much impressed with the necessity of keeping full anesthesia records if we are ever to learn betterment from our mistakes. In this hospital the anesthesia record is kept separately on slips of paper that have several desirable features more especially in that there is a pre-operative part to be filled out by the house officers an anesthesia record to be filled out by the anesthetist and a postoperative part to be filled out by the nurse in the ward when the patient has become conscious It is unfortunate however that these slips are not filed away with the histories but kept separately and that the part involving the actual anesthesia is not full enough. We would like to point out what has been so strongly advocated by Gwathmey (37) Keen (22) Bevan (34 35) Boothby (38) and others that an actual chart record is the best form on which to keep such data. During our investigations we became so convinced of the importance of this point that we consulted the anesthesia records and charts of various

American institutions and evolved the accompanying sheet which we present as a form that includes the data necessary to permit future studies on the advantages or disadvantages of certain anesthetics and on the course and mistakes of certain types of operations It follows in general form the very excellent chart in use at the Peter Bent Brigham Hospital Boston and will probably be put in use in this institution (Figs. 1 and 2)

We have entered into this thorough discussion of the relation of anesthesia to postoperative pulmonary complications because we feel that not only is it the factor most constantly present but it is one which by care and betterment of methods can be to a great extent eradicated And although our analysis has led us to believe that this factor alone is really sufficient to cause postoperative pneumonia it certainly plays a very important contributing part.

In studying further the relation of anesthesia to the postoperative lung complications we thought there might be something of value in a consideration of the seasonal occurrence since there is unquestionably a seasonal increase in the incidence of pulmonary lung disease

We present a postoperative pulmonary complication chart for one year (Fig. 3)

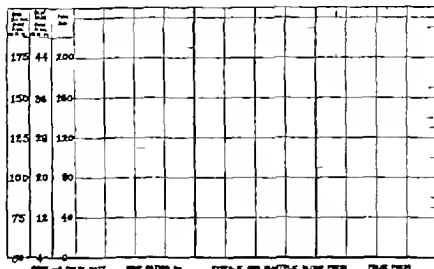
Other writers have also plotted the seasonal incidence of their pulmonary complications and Armstrong (10) shows that of his 55 cases 35 occurred in the five months November to March, while of the 35 complications reported by Robb and Dittick (39) 20 occurred in the four months January to April Thirty nine of our 65 cases came within the six months period November to April This is even more significant when it is realized that the hospital is only at its fullest capacity during the other six months when but a little over one third of the total complications occurred The percentage calculations as plotted on the chart shows this strikingly Osler and McCrae (17) state that the majority of pneumonia cases occur during the interval November to June

A consideration of some of the other predisposing factors brings forward more interesting data The average age of the 65 cases

## ANÆSTHESIA CHART

Ward \_\_\_\_\_ Service \_\_\_\_\_ Date of Operation \_\_\_\_\_  
 Name \_\_\_\_\_ Age \_\_\_\_\_  
 Lungs \_\_\_\_\_ Heart \_\_\_\_\_  
 Operator \_\_\_\_\_ at Asst. \_\_\_\_\_  
 Operation \_\_\_\_\_ Preliminary Drugs \_\_\_\_\_  
 Anæsthetic Amount \_\_\_\_\_ Method of Adm. \_\_\_\_\_

Not — Record of time of starting anæsthetic, beginning of operation, removal of anæsthetic, and close of operation very important



## REMARKS

Struggling or excitement \_\_\_\_\_ Mucus \_\_\_\_\_  
 Vomiting \_\_\_\_\_ Cyanosis \_\_\_\_\_  
 ADDITIO REM. ERS  
 Drains \_\_\_\_\_  
 Closure \_\_\_\_\_  
 Stimulants \_\_\_\_\_  
 Anæsthetist \_\_\_\_\_

Fig.

with pulmonary complications was 43 years. It varied from 57 for the mediastinitis cases and 50 for both the lobar pneumonia and empyema groups to 39 for the bronchopneumonias.

In 26 cases some definite lung pathology was demonstrable at the time of operation.

Other writers have also laid especial stress on this factor. Bibergell (19) in reviewing German statistics records that of 200 lung complications reported by Kelling 13 showed bronchitis before operation. Thirty-four of these developed pneumonia and 17 died — 83 per cent. This is in striking contrast

## POSTOPERATIVE OBSERVATIONS

Conscious at.....

Nausea

Vomiting

Headache

Cough

Thirst

Sig. of Nurse.

Note: P, T, and R, when ordered taken at frequent intervals should be recorded on the Anesthesia Chart.

Fig. 2. Reverse side of chart.

to the operations on patients with normal lungs where only 30 per cent died. In a few of our cases a pneumonia although undoubtedly present before operation was missed entirely in several cases emphysema or a few coarse râles were noted before operation. Septic foci including the lung conditions and cholecystitis, appendicitis, ruptured bowels, etc. were present in 39 cases almost 60 per cent. The importance of septic foci in relation to subsequent lung complications has long been repeatedly shown in statistical studies. It is this factor which is responsible for the large proportion of the embolic complications. The greater number of such cases occur with abdominal sepsis where the anatomical distribution of blood vessels and lymphatics facilitates the ease of extension.

The general risk we have tried to estimate and have considered the age, the pre-existing lung pathology and sepsis elsewhere, cardiac condition and past history. The divisions are arbitrary and those with pre-existing lung pathology we have called poor risks, 21 we have called good, 18 fair and 25 poor risks. These figures are extremely instructive. Only imagine operating on a series of cases one third of which have the description "poor risk" stamped on them before operation! It shows how lightly we approach operation in general and is a just criticism.

Some of these factors at least, can to a great extent be avoided, and this is one of the lessons we wish to point most sharply. Other writers Armstrong (10), Otte (11), Kroenlein

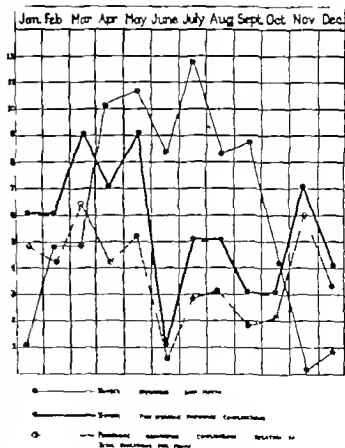


Fig. 3. Postoperative pulmonary complications. Monthly incidence.

(21) and others urge strongly the eradication of septic foci before operation. The lung condition must be thoroughly understood and if there is any question, the operation scheduled must be put off if possible until improvement sets in. Of course there always will be a few cases where the pulmonary risk is great, but in which delay overbalances the danger of immediate surgical intervention. It is interesting to record here that Otte (11) speaks of giving anesthesia to patients with lung trouble (asthma bronchitis etc.) when it seemed absolutely necessary, but that by using great care with the anesthetic all future lung complications were avoided. At least it points a lesson from which many clinics may well take their text.

We had hoped to find another remediable factor in the long duration of some operations. But a careful study of our own cases and of the statistics and opinions of others has brought us to the conviction that the duration of the anesthetic *per se* plays an unimportant part. Of course in poorly administered anesthesia the duration adds to the risk.

In covering the entire field of postoperative complications we have already said that the pneumonia group stands out as the most important class, and thus we have spent much time in analyzing and discussing it but we feel that the same factors are present to a considerable extent in producing bronchitis, i.e. the anesthesia here too plays an important rôle. The pleurisy empyema and pulmonary embolism cases are usually embolic in origin as is to be expected, and we feel that the discussion already presented and the exposition of our series of cases in these various groups is sufficient. Their etiology depends on some area of sepsis or thrombosis which frequently existed before operation, and which, therefore in some cases is avoidable. The mediastinitis and pneumothorax cases are easily explainable on a mechanical basis and need no further discussion.

We hope we have shown much room for improvement, and that such improvement is easily available with study and care in the selection of cases in the pre-operative preparation in the method and skill of the anesthetist, and in the postoperative conduct

## CONCLUSIONS AND SUGGESTIONS FOR PROPHYLAXIS

*Factors predisposing to postoperative pulmonary complications.* From the above studies we have derived the following conclusions as to the etiology of postoperative pulmonary complications. Certain factors weigh more heavily than others but we feel sure that no single specific cause is alone militant in any given group or type. There seems to be present always a large and varying number of factors. Anesthesia has been repeatedly blamed as the main factor responsible for these complications but we feel we have shown that when alone and in good hands it can be disregarded as sufficient to bring about such sequelae. The figures we have presented from this clinic that one in every 54 cases operated upon develops a postoperative lung condition and that 1 in 106 dies are so striking as at once to establish the importance of these sequelae. And it should be a sufficient warning to make any surgeon consider thoroughly all the risks involved and what precautionary methods he might use in each and every case. The predisposing factors are

- 1 Poor general condition i.e. age anemia alcoholism arteriosclerosis weak heart or susceptible lungs. (The type that appears superficially as a bad pre-operative risk.)
- 2 Oral sepsis i.e. teeth carious necrotic, etc. tonsils septic.
- 3 Pre-existing lung pathology — not only tuberculosis but bronchitis emphysema or a recently subsided pneumonia.
- 4 Anesthetic badly given, i.e. forced aspiration of mucus permitted unnecessary intubation of nasopharynx, vomiting on table etc.
- 5 The presence of septic foci.
- 6 Too radical operations that open up unnecessarily pathways to the neighborhood of the lungs or to the lungs themselves.
- 7 Operations in the epigastrium carry the added danger of lung complication through ease of vascular and lymphatic extension.
- 8 Exposure to cooling fluids or to draughts (vasomotor disturbance).
- 9 Postoperative pain resulting in hypostasis from poor expansion.

Prophylactic measures which we suggest to avoid the occurrence of postoperative pulmonary complications

1 Careful preparation of the mouth all oral sepsis from teeth and tonsils eradicated antiseptic mouth wash and extra careful brushing of the teeth the day of operation. Turner (54) emphasizes the importance of mechanical scrubbing of the mouth with citric acid the mere use of mouth washes being insufficient

2 Observation of patient for at least two days before operation to insure absence of lung pathology and septic foci

3 Carefully administered anaesthesia preferably in the hands of an expert ether to be given by the drop method Avoidance of mechanical appliances in mouth and nose unless indicated Surgeon to be ready to operate when patient is prepared

4 Avoidance of exposure during preparation on the table no unnecessary wetting plenty of blankets Again after operation, particular care to avoid exposure plenty of blankets and if the patient is recumbent these to be pinned about the neck. Operating room temperature kept above 75° F The liberal use of hot wet packs in laparotomies in walling-off the operative field

5 Avoidance of trauma especially in the epigastrium and in the neighborhood of large vessels

6 Asepsis.

(In the special group of epigastric operations we suggest that in addition to the above recommendations the wound be closed with silk sutures for the fascia so that tight supporting bandages will be unnecessary thus as far as is mechanically possible, doing away with splinting of the lower portion of the lung We further advise allowing the patients more freedom of movement in bed and would not insist on the semi-erect posture always In addition, we advocate getting the patient up and out of bed just as early as is compatible with the existing conditions in each case)

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W except the introduction of soft rubber catheters int. the nasal passages for the mechanical administration of ether as by the Connell machine, because we believe that the error attending more than over balances the danger of setting loose infected material.

## FAT EMBOLISM FOLLOWING TRAUMA TO BONES

## AN EXPERIMENTAL STUDY OF ITS PRODUCTION AND PREVENTION WITH PARTICULAR REFERENCE TO THE ALBEE OPERATION

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THE importance of fat embolism following bone injuries has recently received considerable emphasis. Buerger (1) examining the lungs of one hundred individuals who had received severe contusions or bone fractures found embolic fat lacking in only one case of severe bone injury. In his excellent monograph Warthin (2) reports that in the eight fatalities following fractures in his pathological service on which autopsies were performed

all showed a marked fatty embolism as the cause of death. It is of significance to note that a clinical diagnosis of fat embolism was not made once in these cases. Le Count and Gauss (3) studying 14 cases of fat embolism found that the symptoms had been recognized clinically only once while the diagnosis of delirium tremens had been made eight times.

The tragic nature of fatal fat embolism in orthopedic operations has given especial significance to these cases. The dangers associated with forced straightening of ankylosed joints were pointed out by de Quervain (4) in 1904 and prophylactic measures were advocated which seemingly attracted but little attention. Von Aberle (5) made similar but more extensive observations in 1907 and outlined means of prophylaxis which are empirical in nature but have had important bearing on orthopedic procedures. The number of well-authenticated fatal cases reported as found by Heck (6) in 1913 to be within the limits of a score doubtlessly serves to illustrate the failure to recognize the condition rather than the rarity of its occurrence. Reiner (7) states that four deaths from fat embolism occurred in the Vienna Institute for Orthopedic Surgery alone within the space of a few years and that three of these deaths occurred in approximately one thousand operations which were performed previous

to the adoption of certain prophylactic measures. Ryerson (8) within the past three years has had three deaths in his own service, which he attributes to fat embolism. Only in the last one of these was the cause of death definitely established. Fat embolism was not suspected at the time in the two earlier fatalities and consequently no examinations were made which would reveal it. One of these cases is of peculiar interest in connection with these experiments. It was an Albee bone transplantation for the correction of a severe paralytic scoliosis. A splint cut from the tibia by means of a motor saw was sewed into a cleft made by splitting the spinous processes of the lower dorsal and upper lumbar vertebrae. The death which occurred three days later is the first one following this type of operation in which fat embolism has been reported and was responsible, in part, for the present study undertaken at Dr. Ryerson's request.

## EXPERIMENTAL PRODUCTION OF FAT EMBOLISM

The relationship which fat embolism holds to lesions of bone tissue was established by the experiments of Busch in 1866 who produced fat embolism in rabbits by boring holes in the tibias and destroying the marrow by means of a wire introduced through these holes in the cortex of the bones. These injuries to the bone marrow were followed constantly by the finding of fat droplets in the capillaries of the lungs. The animals killed at the end of three to six hours had similar amounts of fat with the same wide spread distribution in the lungs, as had the animals which were allowed to live several days.

Busch investigated also the method of transportation of this fat. The marrow was in part removed from the marrow cavities and replaced by an intimate mixture of

olive oil and vermilion. Large amounts of the colored fat were found in the lungs as early as 45 minutes after the completion of the operation. In these cases no traces of pigmented fat were found in the lymph glands along the vena cava and the lymph-glands in the pelvis contained only small quantities of pigment.

In other animals the vena cava was ligated below the entrance of the renal veins and a cannula inserted into its peripheral end previous to the injection of the colored fat into the marrow cavities. When the oil was purposely injected under high pressure the blood flowing from the cannula is said to have contained pigmented fat before the injection was completed while three hours after the injection it was impossible to find pigmented fat even in the vessels nearest to the injured bone. On the basis of these experiments Busch concluded that the fat is taken up from the marrow cavity largely by the veins and that the maximum of the absorption is reached during the first few hours. A much smaller amount of fat is apparently transported by the lymph.

Riedel (10) confirmed the finding of Busch that injuries to bones are constantly followed by the entrance of fluid fat into the blood stream and in addition showed that the intact lymph vessels are capable of taking up fat which has been injected into the subcutaneous tissues. He never observed the production of fat embolism by this means and explained this by the emulsifying action of the lymph-glands.

While he did obtain pulmonary fat embolism with intraperitoneal oil injections, he attributed this to the supposed direct entrance of some of the lymphatics of the diaphragm into the thoracic duct without passage through lymph glands. Fritsche (11) in vestigating this claim recently could find no authority for such assumption and states that Bartels has shown that all of these lymph vessels pass at least one set of lymph glands before reaching the thoracic duct. Wiener (12) likewise obtained abundant pulmonary fat embolism by the injection of fat into the peritoneal cavity of rabbits. The lymphatics of the diaphragm were notice-

ably filled with fat. Olive oil injected into the pleural cavities of dogs and rabbits gave a similar result. Some of these animals were allowed to live from 13 to 19 days following the injections but the experiments were repeated with numerous rabbits, and fat was usually found in the capillaries of the lungs in animals which were killed after two days. These experiments led to the conclusion that even the intact lymph vessels may take up large fat droplets and that the passage into lymph glands does not prevent the accumulation of fat droplets in the capillaries of the lungs.

The work of Ribbert (13) demonstrated the importance of jarring the bones without fracture in the production of experimental fat embolism. He found that by striking the bones of the legs of rabbits a series of blows with a mallet a pulmonary fat embolism was produced. According to his view the jarring of single bones or of the skeleton as a whole is the chief factor in bringing about the entrance of fat into the blood stream. The fat therefore would not necessarily come from that part of the marrow which is directly injured by the trauma as this he thinks could account for only a small amount of fat. To show the relatively slight significance of the tearing of the bone marrow when the jarring is reduced to a minimum he produced fractures in the femurs of rabbits by a very gradually increased pressure. In these animals no fat embolism was noted or at most, it was slight, although the fractures were sufficiently complete for the ends of the broken bones to be moved against each other.

Ribbert thought this would explain the occurrence of marked fat embolism in human beings following perfectly smooth transverse fractures of bones in which only a thin layer of marrow is disturbed and also severe cases following very trivial fractures or fractures of flat bones whose marrow contains but little fat, such as he had observed in fractures of the sternum of ribs and vertebrae, and which he had seen often in skull fractures resulting from falls and other severe traumas.

Using Ribbert's methods Frischmuth (14)



and later Bergemann (15) found traces of pulmonary fat embolism following the jarring of bones unaccompanied by fracture. The repeated falling of narcotized animals from a table to the floor or the throwing of anesthetized animals against the wall caused the entrance of free fat into the blood stream but, in every case the amount of fat found in the lung capillaries was small. In this connection Bergemann noted that the number of fat droplets in general seemed to be dependent upon the age of the animal and the amount of body fat which it possessed. In a few animals in spite of the most careful searching of numerous preparations no trace of fat embolism could be found. These preparations were usually taken from five or six different regions of the lungs and the findings in all of these were generally quite uniform. If traces of fat embolism were found in one of the preparations they were usually found in the majority of the remaining ones. Taking all possible care to avoid jarring and shaking Bergemann observed small amounts of free fat in the capillaries of the lungs following gradual crushing of the spongiosa of the long bones of dogs and rabbits and also after fractures of the shafts of these bones. In these experiments the fat droplets were larger and more numerous than those seen after the jarring of the animals. He concludes that the crushing of bones, accompanied by fracture, is of more significance in the production of fat embolism than is the jarring of bones and that some importance should be attached even to the compression of bones since the forced straightening of joint contractures has shown experimentally in man that the compression of bones without jarring may give rise to a fatal fat embolism.

Careful experimental work in the production of traumatic fat embolism has been done also by Fritsche (11). Using rabbits and dogs he produced fat embolism usually by one of two methods (1) the method used by Busch of boring holes into the marrow cavity near each end of the tibiae, with the destruction of the marrow by means of a wire introduced through the holes and (2) by Ribbert's method of striking the anterior

surface of the tibiae 24 to 36 strokes with a mallet, avoiding injury to the soft parts and jarring of the body in general. Only in a few cases were fractures used to liberate the embolic fat. All of the animals were operated upon in deep morphine-ether narcosis, the excitement stage of ether being avoided by large doses of morphine. While in deep narcosis they were killed by the opening of both pleural cavities care being taken to avoid bleeding with a consequent change in the amount of blood in the vessels of the lungs. The time of these experiments, from the liberation of the fat to the killing of the animals, was usually three to four hours. A few animals were allowed to live 18 to 24 hours without any noticeable increase in the amount of fat in the lung capillaries. The examinations of the tissues for fat concerned themselves chiefly with the lungs since no embolic fat was found in several kidneys examined after three hours.

Usually three or four blocks were removed from the lungs of each animal and sections from each of these were studied. The lungs of a number of rabbits and dogs, killed with the same precautions but without previous bone injuries, contained in some cases a small amount of intracapillary fat. Attention is here called to the fact that it is necessary to differentiate between the large embolic fat droplets and the smaller droplets found in the alveolar epithelium and in the bronchial cells. Fritsche remarks that this finding of embolic fat in the lungs of normal animals emphasizes anew the fact that a slight grade of fat embolism occurs very readily and is without significance. Only in one animal were there no demonstrable traces of fat embolism in the lungs after each tibia had been struck 24 blows with the mallet. This was an underdeveloped rabbit, six weeks old, whose bone marrow probably contained but little fat. In an attempt to settle the much disputed question of whether fat embolism arises only through the blood vessels or whether under certain conditions, the lymph stream can also transmit fat from the bone marrow into the circulation, Fritsche performed a further series of experiments on

rabbits and dogs. Before the production of the fat embolism by trauma to the bones the veins from the legs of five rabbits and one dog were ligated the collateral vessels being occluded as completely as possible. The results obtained are quite remarkable. By merely striking and jarring the extremities in spite of the ligation of the veins the fat droplets in the lung capillaries were found to be as abundant as they were in the controls indicating a transportation of the fat through the lymphatics.

The importance of this route was seemingly confirmed later by the finding of large fat droplets in the lymph from the thoracic duct of animals similarly treated. On the contrary when the fat embolism was produced by fractures of the bones or by disturbances of the marrow accompanied by hemorrhages the results obtained were quite different.

In these animals the ligation of the veins prevented the collection of fat in the lung capillaries. With injuries of this kind the fat embolism apparently arises chiefly by way of the veins. Fritzsche suggests that the lymphatics may be easily closed as a result of the hemorrhage. No hemorrhage was ever observed in the bone marrow following the jarring of the bones in the earlier experiments. Ligation of the common iliac vein alone was not effective in preventing fat from entering the lungs following injuries accompanied by hemorrhage this however was observed in only one animal and then 18 hours after the injury so in this case the fat may have been transported at least in part through the lymphatics.

On the basis of these experiments Fritzsche believes that, at least so far as short time experiments are concerned the lymph channels have no important part in the origin of pulmonary fat embolism following injuries involving hemorrhages into the bone marrow while in connection with the jarring of the long bones unaccompanied by a tearing of the blood vessels the lymphatics are the chief carriers of the fat. In this latter case the emboli formed in a given time are always less numerous than when the blood vessels are torn.

#### PROPHYLAXIS AND TREATMENT

Numerous suggestions have been made in regard to prophylaxis and treatment in fat embolism but the actual experimental work done in this field is quite fragmentary. Probably the earliest attempts in the treatment of an experimentally produced fat embolism were those of Czerny (16) in 1875. Since fat fairly easily forms an emulsion with sodium carbonate solution and as it was known that emulsions injected into animals produced but little effect, Czerny injected fat into the jugular veins of dogs in amounts sufficient to produce dyspnea and then introduced into the same veins varying amounts of 2 per cent sodium carbonate solution hoping that an emulsion would be formed with the fat in the lung capillaries. While he believed the dyspnea was momentarily lessened in some cases there was no evidence of any permanent relief.

The experimental work of Ribbert (13) emphasized the importance of simple jarring of the bones in the production of fat embolism in healthy animals. He maintained that, if with a marrow which is not especially rich in fat such as that in the bones of rabbits this result is obtained it would certainly occur more readily in human beings whose bone marrow is sometimes extremely rich in fat. While Bergemann (15) was unable to convince himself of the fundamental significance of this jarring and shaking he admitted that it might be a factor. He states that if this were truly of so much importance, the use of the chisel in surgery would have to be dispensed with because of the attendant danger and remarks that because of this possible danger Lexer always preferred the saw to the chisel in operations on the spongia of bones especially atrophic ones. Reasoning from the results of experiments similar to those of Ribbert, Wilms (17) attributed to the lymphatics a considerable importance in the transportation of fat. If we maintain that the fat is taken up by the veins the maximum grade of fat embolism should develop in the course of a few hours which appears to be contrary to clinical observations. In this case he states there would be no other means of combating its origin than to incise

the region of the injury in order to remove the fat and the blood which has escaped. He suggests that if the lymphatics serve as the chief means of carrying the fat, benefit might be secured by a temporary drainage of the thoracic duct to the exterior of the body.

This method was used by Wilms with a man 20 years of age who had fallen out of a second story window and who later developed symptoms of fat embolism. From the fistula produced two liters of lymph were collected during the first 20 hours after the operation. This fluid is said to have contained large droplets of fat in addition to small droplets presumably derived from ingested fatty materials. Recovery ensued and the fistula closed after four days. This observation led to Fritzsche's study of the effect produced by draining the thoracic duct in rabbits and dogs in which traumatic fat embolism was produced.

The work was limited to three rabbits and two dogs. By striking the tibiae as in the experiments previously cited no fat droplets were found in the lung capillaries of three animals when the lymph was led out through cannulae in the thoracic ducts while fat droplets were demonstrable in the fluid which escaped. However the results were quite different when holes were bored into the tibiae and the bone marrow broken up as was done with one dog and one rabbit. In spite of an abundant flow of lymph from the thoracic duct no fat droplets were found in this fluid but on examination of the lungs fat droplets were found in the pulmonary capillaries. These findings are in accord with Fritzsche's conception of the different routes for the transportation of the fat in his two types of trauma to bones. In regard to the suggestion made by Wilms he states that only in cases of shaking and jarring of the skeleton without bone fracture would the draining of the thoracic duct be of any prophylactic value and in such cases the symptoms would have to be recognized early.

On a clinical basis von Aberle (5) in 1907 outlined a method of prophylaxis to be followed in orthopedic operations which has received wide attention. The chief features

of this method are briefly expressed as follows (1) Since fat embolism following orthopedic operations occurs most frequently with paralytic contractures in extremities which have been long in disuse, he advocates increased care in the prevention of the formation of such contractures and of the recurrence of the condition, when once corrected. (2) Operations should be done as early as possible when once deemed necessary since with increasing age there is increased fat content of the bone marrow as well as danger of bone atrophy. (3) Since many of these operations are done in bloodless fields, with the use of the Esmarch constrictor it is suggested that the fat collected in the veins may be washed suddenly into the circulation unless the constrictor is removed gradually. (4) When contractures must be operated upon fractures should be carefully avoided and multiple contractures should never be treated all at one time and in case of high grade contractures the correction should not be attempted at a single operation. If bones are accidentally broken, they should be set as carefully as possible.

Reiner (7) in the worst of these cases has used a bloodless field in both open and closed operations but before the removal of the Esmarch constrictor has placed a cannula in the saphenous vein in such a way that it extends down into the femoral so that on removal of the Esmarch the blood containing the fat collected from the tissues is allowed to flow outside. Relatively large amounts of fat are said to have been obtained in this way. However these suggestions do not seem to have been very widely adopted. Having occasionally observed convulsions following certain orthopedic operations, Schanz (18) is convinced that these might have been avoided if von Aberle's directions were followed when they have actually appeared he has used subcutaneous injections of salt solution, from which procedure he obtained the impression that beneficial effects resulted. This treatment is based on the assumption that the convulsions are due to the plugging up of capillaries in the brain. By this means the capillaries can be distended and the fat droplets forced onward.

Some years before the publication of von Aberle's prophylactic measures de Quervain (4) had emphasized the dangers associated with the compression of the spongiosa of atrophic bones and had given directions by which to avoid the dangers associated therewith. He especially recommended the use of the X rays in diagnosis of the extent of osteoporosis and if this were extreme the use of forced straightening should be avoided and more gentle methods applied as previously advocated by Payr. In a recent review of traumatic fat embolism Tanton (19) holds that the immobilization of fractures is a further factor in prophylaxis if hipura and dyspnea have developed the opening up of the fracture with removal of the blood and fat accumulated there should be considered. Since the beginning of the experimental work here reported Buerger (20) has advocated the use of the Esmarch constrictor especially in fractures accompanied by contusions in order to hinder the further destruction of the fatty tissue by the blood and to prevent the entrance of fat into the veins by this means also the clotting of the blood in the crushed fatty tissues would be hastened. By experiments to which reference only is made, he states that he has shown that fat which has become free is frequently retained by the coagulum when the blood clots. For this purpose, he says the constrictor would probably not have to be left on longer than a half hour to hasten the clotting gelatin might be injected before the removal of the Esmarch but he opposes this procedure on the theoretical grounds that thrombosis might also be hastened in the vessels containing the emboli. Venesection of the injured limb previous to the removal of the Esmarch bandage might be of some value as suggested by Reiner. Buerger even advises Mombert's constriction at the waist line in the most severe cases especially with crushing injuries of the pelvis.

#### EXPERIMENTS

The purpose of these experiments was to devise a method which would produce a relatively constant amount of fat embolism by means of trauma to bones and then with

this method to test the value of the use of the Esmarch constrictor or tourniquet as a prophylactic measure against the fat embolism so produced and further to seek other means of limiting the amount of fat entering the circulation. The Esmarch constrictor has long been used for the production of bloodless fields in various operative procedures but its use as a means of prophylaxis against fat embolism has only recently been suggested and its value never actually determined. In his directions for the prevention of fat embolism von Aberle suggested that the Esmarch constrictor be removed gradually so that large amounts of fat would not be washed suddenly into the blood stream but he was referring here only to those operations in which bloodless fields were being employed and does not mention its use as a prophylactic measure. Reiner however states that, in his worst cases those involving paralytic contractures with marked atrophy of the bones involved he used the Esmarch in both open and closed operations and before removing it, drained the fat-containing blood from the femoral vein. Previous to the adoption of this procedure three fatalities from fat embolism occurred in his service. Some months after the beginning of the experimental work here reported Buerger (20) published an article in which he strongly advocated the use of the Esmarch constrictor in bone fractures to hasten the clotting of the blood in the injured tissues and thus prevent the escape of the free fat.

Large and at least moderately well nourished rabbits and dogs were used in our experiments.

*Production of anesthesia.* To avoid the excitement stage of ether anesthesia a narcotizing dose of chloral hydrate was first given to all animals. For this purpose a solution of uniform concentration was used throughout 1 cubic centimeter of the solution was equivalent to 0.1 gram of chloral hydrate. This solution given per rectum to rabbits in the ratio of 0.3 grams of the crystals to 1 kilogram of body weight gave a deep narcosis beginning in 5 to 15 minutes and lasting usually about an hour. The sub-

sequent administration of ether was accomplished without much resistance on the part of the animal. With dogs a stomach tube was used and the chloral hydrate solution was introduced directly into the stomach. This method of anaesthesia while uniformly satisfactory with rabbits sometimes failed with dogs because of the vomiting which frequently occurred. In such cases chloroform was used to produce the anaesthesia and ether was substituted later.

*Killing of animals and preparation of the tissues.* In these experiments the animals were usually allowed to live 5 hours following the operation; a few were killed at the end of 2 1/2 and 3 hours and one was allowed to live 10 hours. Some of the rabbits were killed by placing them in a large bell jar and then gradually increasing the content of illuminating gas in the enclosed air; the remaining rabbits and all of the dogs were given preliminary doses of chloral hydrate as in the initial anaesthesia and this was followed by ether or chloroform. The thoracic and abdominal cavities were opened and the vessels from the lungs, heart and kidneys ligated. These organs were then removed with as little loss of blood as possible, in order that their fat content should not be altered. These intact organs were placed in 10 per cent formalin where they were allowed to remain for a week. Frozen sections of approximately uniform thickness (about 40 microns) were prepared and stained for fat with a saturated solution of scarlet R in a mixture of equal volumes of acetone and 70 per cent alcohol as recommended by Warthin (2).

*Estimation of the amount of embolic fat*

The microscopic examination of the organs for fat was confined chiefly to the lungs, since numerous preliminary observations had shown that in these short time experiments fat droplets are not usually found in the capillaries of the kidneys, myocardium, and brain as had been noted previously by others. Blocks of tissue were taken from each of the lobes of the lungs and several sections were made from each of these. To estimate roughly the amount of fat in the lung capillaries the fat droplets in low power

microscopic fields (Leitz No. 4 eyepiece and No. 3 objective. Magnification 103) were counted. In general 20 fields were counted in each section or a minimum of 100 fields in each pair of lungs. Where the fat droplets were few twice this number of fields was examined. The fat droplets in each section, and also in different experiments, varied greatly in size so an attempt was made to estimate more accurately the amount of fat by recording the approximate diameter of each fat droplet in each field examined. This method was persistently followed in the later experiments and it was noted that when the fat droplets were numerous large droplets were proportionately more abundant when there were few droplets they were mostly relatively small. For comparative purposes where only wide differences are of much significance it is considered sufficient to report only the number of the fat droplets.

*Operative procedures and results.* To secure a suitable means for the production of a fairly constant and abundant fat embolism three different operative procedures were used.

1. A slight modification of the method used by Rubbert and later by Fritzsche was first tried. When the tibias of rabbits were struck numerous sharp blows with a percussion hammer only the slightest amount of fat embolism was produced. A few fat droplets were usually found in the lung capillaries of each section examined, but often only 2 or 3 in the entire section of at least 1 square centimeter. This amount was, therefore entirely inadequate for attempts at prophylaxis.

2. A considerably greater but still in sufficient amount of fat embolism was then produced by a method similar to that used by Busch. A hole was bored in each end of each tibia and the marrow partially broken up by a wire introduced through these holes into the marrow cavity. In sections made from the lungs of two rabbits, the fat droplets found in the capillaries averaged only 1.5 per low power microscopic field.

3. The following method was then adopted. After cutting the sciatic nerves in rabbits in

order to prevent pain subsequent to narcosis, the tibias were crushed throughout practically their entire length by means of a small pipe wrench, each leg afterward being struck approximately 36 light taps with a small wood mallet.

This is the method which was used in the first series of experiments on prophylaxis, although the amount of fat found in the lung capillaries following such procedure was not as abundant as desired for this purpose. Upon recovery from the anesthesia, some of the animals were given liberty to move around freely while in other cases especial care was taken to keep them quiet, to see if the amount of pulmonary fat embolism could be reduced by this means. Two of the rabbits in the first group were kept suspended in a towel provided with holes through which the legs were passed the remaining three animals were allowed to move at will. The amount of pulmonary fat embolism is expressed in the average number of fat droplets found per low power microscopic field as shown in Table I.

TABLE I

Rab.	Weight lb.	Duration of Experiment Hours	Condition of Animal during Experiment	Average Number of Fat Droplets
1	2700	5	Moved at will	9.1
2	2850	5	Moved at will	14.5
3	1225	5	Moved at will	0.5
4	2250	5	Suspended in towel	8.3
5	1900	5	Suspended in towel	7.9

This table reveals considerable variations in the average number of fat droplets per field in the different animals. Numerous factors doubtless are concerned in the differences here noted but, with the exception of No. 3 the disagreement is not so great as to be fatal for the present purposes for moderate variations must be expected because of differences in the amount of fat in the bone marrow of different animals because of the varying amounts of fat freed by the crushing of the bones, because of the much greater activity of some animals following recovery from the anesthesia and also because of irregularities of distribution in the lungs. The small amount of fat in the lungs of No. 3 can be explained in part at least, by the size and condition of the animal. It was a small half grown and poorly nourished rabbit

whose bone marrow like the remainder of its body probably contained only small amounts of fat perhaps the age factor here is fully as important as the amount of body fat. However even including this animal the general average of the number of droplets per field is 8.0 and the average weight of the five rabbits is 1985 grams. In general it was noted that, with the same amount of injury a larger amount of fat embolism is produced in the larger and heavier animals.

No benefit seems to have been gained here by suspending the two rabbits in towels attached to a suitable frame. Whether this procedure had the desired effect of preventing trauma to the injured limbs may well be questioned. The unnatural position occasioned considerable struggling which undoubtedly interfered with the occlusion of the vessels by thrombi.

In the next group of experiments Esmarch constrictors were placed on the legs of rabbits proximal to the joint between the tibia and femur previous to the crushing of the tibias. These rubber bandages were about 90 centimeters long and about 2.5 centimeters wide and were applied with sufficient tension to prevent the entrance of blood into the more distal portions of the extremities. They were removed at varying intervals after the crushing of the tibias and the effects noted as in Table II.

TABLE II

Rab.	Weight lb.	Duration of Experiment Hours	Esmarch Constrictor	Condition of Animal during Experiment	Average Number of Fat Droplets
6	2450	5	On full time	Moved at will	0.1
7	2375	5	On $\frac{1}{2}$ hours	Moved at will	0.5
8	2350	5	On $\frac{1}{2}$ hours	Moved at will	3.1
9	2350	5	On $\frac{1}{2}$ hours	Very active	4.1
10	2950	5	On 2 hours	Quiet with chloral	0.5
11	2250	5	On 2 hours	Suspended in towel	2.2
12	3000	5	On 2 hours	Suspended in towel	1.1
13	1875	5	On one hour	Distinctly quiet	1.2
14	1975	5	On one hour	Moderately active	6.0
15	2475	5	On one hour	Moderately active	2.6
16	2420	5	On $\frac{1}{2}$ hour	Moderately active	0.8
17	2100	5	On $\frac{1}{2}$ hour	Distinctly active	6.7
18	2100	5	On $\frac{1}{2}$ hour	Moderately active	15.3

When these results are compared with those in the previous table, it is seen that the amount of fat in these lungs as judged by the number of fat droplets per field is distinctly less. The general average per field

in this series is 3.5 as compared with 8.0 in the earlier series while the animals used here were somewhat larger averaging 2320 grams as compared with 1985 grams. Leaving the rubber bandages on the legs during the entire experimental time almost completely prevented the entrance of fat droplets into the capillaries of the lungs.

This is of significance only in proving that the fat found in the lungs in these experiments has its origin almost solely in the injured limbs. When the Esmarch constrictors were left on  $2\frac{1}{2}$  hours and then removed, the amount of fat embolism which developed during the remaining 2 2 hours even if the animals were allowed to move freely averaged 6 droplets per field which in this numerical standard is only one third of the number found when no prophylactic measures were employed. During the experiment it was noticed the No. 9 was markedly active so much so that it attracted especial attention. This may account at least in part for the greater fat-content of these lungs.

The next animal in the series was kept quiet with occasional doses of chloral hydrate after the removal of the constrictors at the end of 2 hours. These combined preventive measures reduced the amount of fat in the lung capillaries almost to a minimum the average being 0.5 droplet per field. The next two animals of the group Nos. 11 and 12 were kept suspended in towels after the removal of the constrictors at the end of 2 hours. Moderately low averages were obtained in these cases, but not distinctly less than with the animals which were given their freedom following the removal of the bandages. As previously stated this towel suspension is not a very effective means of keeping rabbits quiet.

An attempt was then made to see if the same beneficial effects could be obtained by the use of the constrictors for briefer periods so that its use might be more applicable to the usual orthopedic operations. The rubber bandages were left on the legs of rabbits Nos. 13, 14 and 15 for one hour and then removed. Rabbit No. 13 remained distinctly quiet following the removal of the con-

strictors while the other two animals were moderately active. The average obtained with these three animals is 3.6 or slightly less than half the number obtained in those cases in which no prophylactic measures were used.

The Esmarchs were left on the legs of the last three animals of this series only 30 minutes after the crushing of the tibias. In the lungs of No. 16 the number of fat droplets averaged less than one for each microscopic field although the animal did not remain distinctly quiet following recovery from the anesthesia the note recorded at the time of the experiment being only moderately active. The same note was recorded also for No. 18 in the lungs of which there were found many times as much fat. This difference is seemingly not dependent solely upon the activity of the animals even though they are of equal size.

The general average obtained for the three animals with which the constrictors were used for 1 hour is 7.6 or only slightly less than the average obtained when no preventive measures were used. This result is not surprising when it is recalled that the entrance of fat into the lung capillaries could be almost completely prevented by continued chloral hydrate anesthesia, and that the animals here used rarely recovered from the anesthesia during the first half hour after the operation. In these cases, therefore, the Esmarchs are removed before the animal begins to move about, previous to which time but little fat enters the lung capillaries as indicated by subsequent experiments.

In another series of rabbits further observations were made on the effect of narcotic doses of chloral hydrate in preventing fat embolism. The experimental time was here varied from the usual five hour period (Table III).

TABLE III

Rab.	Weight in Grams	Duration of Experiment in Hours	Esmarch Constrictor	Condition of Animal	Average Number of Fat Droplets
3	550	$\frac{1}{2}$	Not used	Moved at will	8.1
14	2450	3	Not used	Moved at will	5
3	2650	3	Not used	Quiet with chloral	9
16	2900	3	Not used	Quiet with chloral	5
7	550	3	On full time	Quiet with chloral	5
18	2450	3	Not used	Moved at will	3.2

The first two rabbits in this series seem to show that the fat droplets are as abundant in the lung capillaries at the end of 2½ and 3 hours as they are at the end of 5 hours. It is necessary to note this fact in order to be sure that the lessened amount of fat found in the lung capillaries when the Esmarch constrictors are used is not due simply to the briefer period allowed for the collection of the fat in the capillaries. Rabbits Nos. 15 and 16 were kept quiet by occasional doses of chloral hydrate during the entire time of the experiment, no Esmarch constrictor being used with these animals. This proved just as effective as the use of the constrictors for the two-hour period. With the constrictors on during the full time as with No. 17 only a very slight amount of fat embolism would be expected. The result obtained with No. 18 indicates that the number of fat droplets in the lungs of these experimental animals is no greater and is probably even less at the end of 10 hours than it is with the briefer three or five hour periods. Sections from the kidneys and myocardium of this animal contained moderate amounts of embolic fat: the average of 10 fields from the capsule to the pelvis of the right kidney was 1.1 droplets per field while 10 fields counted in the myocardium gave an average of 1.3 droplets. Apparently with the ten hour experimental period a large part of the embolic fat passes through the pulmonary capillaries and is widely scattered through the greater circulation.

A comparison of the results obtained with the 7 rabbits which were allowed to move about freely or were simply suspended in a towel indicates that a fairly constant amount of pulmonary fat embolism is produced by crushing the tibias of rabbits and that a rough estimation of this amount, for comparative purposes, can be made by counting the fat droplets in many representative microscopic fields. The general average for these animals is 8.5 droplets per low power microscopic field or when the small half grown rabbit No. 3 is omitted the general average becomes 9.8. If the 6 rabbits are considered in which cases the Esmarch constrictors were used for a period of 2 hours or 2½ hours and

then removed the general average is found to be 1.9 fat droplets per microscopic field as compared with 8.5 when no attempt was made to prevent the entrance of fat into the blood stream.

The fact that only a small amount of fat was found in the lung capillaries of the two animals which were kept quiet with occasional doses of chloral hydrate without any other precautions being taken indicates that in these healthy animals the trauma subsequent to the crushing of the bones is a larger factor in the production of fat embolism than is the crushing itself. The importance of these postoperative traumatisms is shown also in those animals with which the Esmarch constrictor was used. The rabbit which was most active, following the removal of the constrictors is the one in which the greatest amount of fat embolism occurred; on the contrary the one which was kept quiet with chloral hydrate following the removal of the constrictors had the least amount of all except one on whose legs the constrictors were left during the entire experimental time.

#### FAT EMBOLISM PRODUCED BY THE ALBEE BONE TRANSPLANTATION OPERATION

Because of an occasional and unexplained death following the Albee bone transplantation operation in paralytic scoliosis and tuberculous spondylitis (Pott's disease) and because of a possible relationship between fat embolism and postoperative pneumonias similar operations on animals were planned to determine the amount of fat embolism produced. Wolcott (21) states that out of the 198 operations of this kind performed by Dr. Albee previous to January 1, 1915 one child of 6 years died the day following the operation probably from shock; another patient died of status lymphaticus and still another of pneumonia, one week after the operation. One fatality following this type of operation is reported by Ryerson (4) as in all probability due to fat embolism. This apparently is the only case reported to date in which fat embolism was even suspected. If these operations when performed on experimental animals produced even a moderate amount of fat embolism a standard procedure



dure would then be available for subsequent testing of means of prophylaxis.

**Methods and results.** For these experiments 18 rabbits and 7 dogs were used all of which were allowed to live 5 hours after the completion of the operation. The rabbits were anesthetized as in the earlier experiments the dogs were similarly treated except that 0.35 grams of chloral hydrate per kilogram of body weight was given in solution by stomach instead of by rectum. An incision was made through the skin and underlying soft tissues over the most superficial portion of the tibia and extending from one end of the bone to the other. By means of a motor saw such as is now commonly used for this purpose a splint of bone approximately 5 centimeters long and 0.3 to 0.5 centimeters wide was removed from each tibia of the rabbits. This could be done with very little jarring or disturbance of the bone marrow. The skin incision was then carefully closed to prevent loss of blood. In the complete operation these tibial splints were then sutured into a cleft made by splitting the spinous processes of six vertebrae in the lower dorsal and upper lumbar region. This attempted splitting of the narrow spinous processes was not always successful but the amount of trauma to which they were subjected was equalized as nearly as possible.

To determine the amount of fat embolism produced in rabbits by removal of the tibial splints alone a narrow strip of bone was removed by means of a motor saw from each of the tibiae of 4 rabbits. No attempt was made here to produce any unnecessary injury to the bone marrow. A subsequent examination of the lungs revealed only a very limited amount of fat in the capillaries. The general average of the number of fat droplets per low power microscopic field was 0.35 or one fat droplet for three fields. The average in the different animals ranged from 0.1 to 0.6 but this largest amount can be accounted for in part differently since the animal from which these lungs came fractured a leg soon after the operation. It is seen, therefore that this slight injury to the bones in the removal of splints from the tibiae produces an appreciable but not a large amount of

pulmonary fat embolism in rabbits. Table IV shows the results obtained with the different animals.

TABLE IV

Rabbit	Weight Ounces	Operation Performed	Average Number Fat Droplets per Field
9	350	Splints from tibiae	4
20	50	Splints from tibiae	6
	500	Splints from tibiae	3
	300	Splints from tibiae	

Leg broken.

To see if any fat could be found in the lung capillaries following injuries to the subcutaneous fatty tissues and the trauma due to the splitting of the spinous processes the spinal part only of the Albee operation, was performed on 4 rabbits. The incision over the spinous processes was made sufficiently long to give access to six vertebrae in the lower dorsal and upper lumbar region, and the processes were then split with a chisel. The amount of fat embolism produced as judged by the number of the fat droplets in the capillaries of the lungs, is distinctly greater than that produced by the removal of the tibial splints. The average for the two animals which survived the operation is 1.6 droplets per field as compared with a general average of 0.35 in the earlier series. Two of the 4 rabbits in this group died just before the completion of the operation. The tissues from these animals were preserved in the usual way and the lungs later examined for their fat content. Even in the brief time that the animals lived after the beginning of the operation a considerable amount of fat embolism had developed the average for the two being 0.75 fat droplet per field. Nothing was found to account for the death of these animals but it might be due to mechanical interference with respiration, since they were placed on their bellies during the splitting of the spinous processes. The individual results are shown in the Table V.

TABLE V

Rab-Weight Fat	Weight Gmms	Operation Performed	Average Number of Fat Droplets	Remarks
3	900	Spinal part only	4	Died during operation
24	300	Spinal part only	7	Killed at end of 5 hours
5	700	Spinal part only	5	Killed at end of 5 hours
26	900	Spinal part only		Died during operation

Complete Albee operations including both the removal of the tibial splints and the splitting of the spinous processes were then performed on 4 rabbits with results as shown in Table VI

TABLE VI

Rabbit	Weight Grams	Operation Performed	Average Number of Fat Droplets per Field
27	2500	Complete Albee	1 3
28	2450	Complete Albee	1 7
29	2550	Complete Albee	1 7
30	2200	Complete Albee	1 6

The general average of the number of fat droplets per microscopic field is here again 1.6 or exactly the same number obtained when only the spinal part of the operation was done. The latter however was the general average from only two pairs of lungs and the apparent error is not great since the general average obtained from the tibial part of the operation is only 0.35 per field.

Since the amount of fat embolism produced by the removal of the tibial splints was entirely inadequate for use in connection with preventive measures an attempt was made to obtain a larger and yet fairly constant amount by breaking up the marrow of the tibiae after the removal of the strips of bone. Esmarch constrictors were used with 4 of these rabbits to produce bloodless fields in two cases the rubber bandages were left on during the entire operation, being removed immediately after the wound had been closed with sutures while in the remaining two cases the constrictors were removed before the wound was sewed up thus giving some opportunity for the escape of the fat-containing blood. The irregularities in the results obtained in this series of animals baffle all attempts at interpretation. The results are given in Table VII

TABLE VII

Rab-Weight	Operation	Esmarch Constrictor	Average Number of Fat Droplets
bkt Grams	Performed		
3 2050	Splints removed and marrow broken up	Not used	0 8
3 2050		Not used	2 8
33 2850		During entire operation	8 1
34 330	marrow broken up	During entire operation	2 1
35 2650		Removed before sewing up	3 1
36 2500		Removed before sewing up	7 7

*Fat embolism produced by the Albee operation when performed on dogs* Because of the

small amount of fat embolism produced in rabbits by the unmodified Albee operation it was decided to perform similar operations on dogs. For this purpose 7 large mature and moderately well nourished dogs were used. Table VIII shows the operations performed and the results obtained

TABLE VIII

Weight Dog grams	Operation Performed	Remarks	Average Number of Fat Droplets
1 15 5	Splints from tibiae	Marrow broken up	2 5
2 10 5	Complete Albee	Marrow broken up	1 6
3 17 8	Complete Albee	Marrow not disturbed	0
4 17 0	Complete Albee	Splints removed with chisel	0 5
5 1 0	Complete Albee	Splints removed with chisel	0 1
6 22 0	Complete Albee	Splints removed with chisel	0 2
7 14 0	Complete Albee	Splints removed with chisel	0 5

When the bone marrow of the tibiae was broken up with a probe as with dogs 1 and 2 a moderate but seemingly inconstant amount of pulmonary fat embolism was produced. With the unmodified Albee operation the tibial splints being removed by means of a saw the lungs of Dog 3 contained a minimum of free fat averaging only one droplet for 10 microscopic fields. It was therefore apparent that the Albee operation liberates too little fat from the bone marrow of normal dogs to be used for the testing of prophylactic measures.

Because of the commonly accepted view that the use of the chisel in certain bone operations increases the danger of fat embolism complete Albee operations were performed on 4 dogs, the tibial splints being removed by means of a chisel. In these operations a comparatively dull chisel was used and an effort was made to produce as much jarring of the bone as could reasonably accompany the removal of such splints from the healthy tibiae of dogs. The results obtained from a subsequent examination of the lungs of these dogs for intracapillary fat, as shown in the above table gave a general average of only 0.33 droplet per field or only one droplet for three microscopic fields. This seems to show quite conclusively that the use of the chisel in the removal of splints from the healthy bones of dogs does not increase very appreciably

ciably the amount of fat embolism produced above that produced when the motor saw is used

#### DISCUSSION OF RESULTS

The fairly constant numerical values obtained by counting the fat droplets in the lung capillaries following the crushing of the tibiae of normal mature rabbits is evidence that this procedure when unrestricted gives rise to comparable amounts of fat embolism

Furthermore any marked decrease in this numerical value as observed in a series of animals can be interpreted as indicating a smaller amount of pulmonary fat embolism. With this as a standard it is possible to compare the amounts of fat liberated by different operative measures. The striking of the otherwise uninjured tibiae is thus seen to produce a very slight amount of fat embolism as compared with the crushing of these bones. Likewise the destruction of the bone marrow as completely as possible by means of wires introduced into the marrow cavities through holes at the ends of the bones, or the breaking up of the marrow with a probe after the removal of splints from the tibiae produces a much smaller amount of fat embolism than does the crushing of the tibiae. That the latter causes a larger amount of fat to enter the blood vessels may be due in part to the greater injury to the fat-containing tissues but it is probably due largely to the greater interference with the clotting of the blood or rather the disturbance of the clots by the postoperative activities of the animals. The trauma in these cases is exerted on the injured tissues which are no longer protected by intact bone. In support of this is the result obtained when the animals are kept quiet with chloral following the crushing of the tibiae; no greater amount of fat was found in the pulmonary capillaries of these than was found in others when the marrow was broken up and the bony framework left intact as a support for the injured marrow.

That Esmarch constrictors when left on the legs of rabbits for 2 hours after the crushing of the tibiae distinctly lessen the amount of fat entering the circulation during the remainder of the experimental period seems

apparent from the data here presented. This preventive action may indeed be due as suggested by Buerger to the earlier and firmer clotting of the stagnant blood, a part of the free fat being retained in the clot and the torn vessels being occluded by thrombi. The fact that activity on the part of the animal following the removal of the constrictors may offset to some extent the advantage gained by their use shows that even after clotting has occurred trauma to the injured limbs may still cause the entrance of some fat into the blood stream and emphasizes the importance of early and complete fixation in those cases in which there is danger of fat embolism. The use of the Esmarch constrictors for periods of 30 minutes or even one hour after the operation, furnishes only a slight or uncertain protection against the subsequent development of pulmonary fat embolism in rabbits which are allowed to move about freely after the removal of these constrictors. Those animals which remain distinctly quiet during the whole experimental period will usually have relatively few fat droplets in their lung capillaries but this will usually be true as well when the constrictors have not been employed at all. If coagulation of the blood in the injured area is an important factor in preventing the entrance of fat into the blood stream as is here indicated, it is suggested to us by Dr. Wells that applications or injections of kephalin or brain lipoids (22) made at the site of operation, might hasten the clotting of the blood as discovered by Howell (23) and thus lessen the time necessary for the use of the constrictors.

#### CONCLUSIONS

1. Crushing the tibiae of mature rabbits produces a moderate and fairly constant amount of fat embolism as determined by counting the fat droplets in a large number of representative microscopic fields in stained sections of lung tissue.

2. Esmarch constrictors placed on the legs of rabbits, previous to the crushing of the tibiae and removed after two hours lessen distinctly the amount of fat entering the lungs during the remainder of the experi-

mental period this effect is much less marked and more uncertain when they are removed at the end of a half hour or even one hour.

3 The amount of fat embolism which develops after the removal of the constrictors is dependent largely upon the activity of the animals.

4 Rabbits kept in chloral hydrate narcosis during the entire experimental period following the crushing of the tibiae develop only a small amount of fat embolism although the constrictors are not used.

5 The removal by means of a motor saw of splints from the tibiae of normal dogs and rabbits produces an appreciable but a very small amount of pulmonary fat embolism.

6 The use of the chisel for the removal of the tibial splints from dogs increases very slightly if at all the amount of fat entering the circulation.

7 The spinal part of the Albee bone transplantation operation on normal rabbits produces more fat embolism than does the tibial part.

We wish to express our indebtedness to Dr H Gideon Wells for his helpful direction

of this work and to Dr E W Ryerson for suggesting the problem and for furnishing the motor saw used in these experiments.

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## SEROUS MENINGITIS FOLLOWING TRAUMATISM<sup>1</sup>

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THE fact that a serous meningitis without any other complicating injury to the brain following an injury to the head could cause death unexpectedly came to my attention in the year 1903

A man fell forty feet from a coal dock and was picked up unconscious with a compound fracture of the right wrist. He remained unconscious only a few minutes was removed to a hospital the fracture was operated on under an anæsthetic and for five days the man was apparently normal. On the sixth day he began to have headache and this was followed by a progressive right hemiplegia, which was complete on the ninth day when I first saw him in consultation. Believing that he had probably fractured his skull on the left side and that a hæmorrhage was taking place from the posterior branch of the middle meningeal artery I advised

an operation to remove the blood-clot. This was declined.

The following day the man became totally unconscious and when he was in a state of coma permission was given to operate. I trephined the skull over the middle fossa and found no clot. Upon opening the dura, the cortex of the brain presented an ecchymotic appearance. No cerebrospinal fluid appeared. I passed a grooved director between the dura and brain and a few drops of cerebrospinal fluid escaped. In a few minutes the flow increased to a small stream. At the end of fifteen minutes the patient began to show signs of life. The breathing improved. The operation was performed without an anæsthetic. A drain was inserted beneath the brain and the wound closed. The man made an uneventful recovery and is still living.

A review of the literature of the surgery of the brain will give but little information on traumatic serous meningitis. The pathol-

ogy deals almost entirely with cysts the result of hemorrhage. It is recognized that fracture of the skull is not a necessary factor as the elasticity of the cranium will permit of trauma to the contents of the skull. There is no doubt that cases similar to the one reported have been seen from time to time and they may be reported in the literature but if so they have escaped my attention.

For years this case has been in my mind. In the examination of head injuries with marked symptoms of cerebral compression hemorrhage is usually considered. For a long time it has been my custom to bear in mind also the possibility of a simple serous effusion especially when no focal symptoms are present. Within an hour following a serious contusion of the membranes of the brain fatal compression of the brain can occur from a serous meningitis without hemorrhage in fact a valuable aid to the prognosis of recovery is the finding at the time of operation of a free amount of cerebrospinal fluid.

Last summer I watched a moving picture illustrating the steps in a decompression operation in which a young surgeon of considerable ability and enthusiasm was busily chipping away the skull. After a sufficient opening had been made to show a freely pulsating brain and a large amount of cerebrospinal fluid, I thought that were the surgeon familiar with the favorable prognosis the initial opening of the skull showed he might have spared the patient some useful bone.

In reviewing the clinical history of serous meningitis cases I am impressed by the fact, that as a rule there is no primary unconsciousness a history of being momentarily stunned is about the extent of the complaint. The symptoms all of the patients complain of is a frontal headache of severe character. These two facts stand out prominently. The stage in which the case is first seen by the surgeon will show a group of symptoms that are characteristic of cerebral compression. Seldom have we found a choked disc. In every case however there has been noticed a tortuosity of the retinal veins.

If the operation is done within forty-eight hours of the accident, in nearly every case

there will be found a free amount of fluid provided of course that the injury received did not cause hemorrhage. I am prepared to say that many cases of serous meningitis following blows on the head are not recognized because hemorrhage has been considered only in the light of a causative factor and we have not as yet learned to think in terms of serous meningitis. We have yet to learn that a simple contusion of the dura, uncomplicated by hemorrhage can produce the same condition. The unyielding unbroken calvarium furnishes the counter pressure for a hydraulic pressure, beneath which the delicate brain structure is compressed. The man who falls backward from a load of hay and does not fracture his spine the man struck on the forehead with a fragment of a pulley from a revolving shaft the man who slips backward on an icy pavement and strikes his head sufficiently hard but not hard enough to cause hemorrhage the automobile accidents the trolley accidents the baseball accidents the elevator accidents the falls from ladders these are the more familiar cases that have furnished material for this paper.

It would indeed be misleading to leave the inference that serous meningitis uncomplicated by hemorrhage is found only in comparatively mild injuries to the skull. Such is not the case. Fracture of the skull may occur without hemorrhage of the brain and without serous meningitis. The important fact to be kept in mind is that even with hemorrhage the accompanying edema of the brain unrelieved by decompressive measures may cause a fatal issue. The turning up of the dural flap in Cushing's decompression is the most important factor of the technique other than the opening of the dura itself.

The following case which is somewhat dramatic because of its legal aspect, illustrates what may follow a trivial insignificant injury to the head. More than a year has passed since the injury was received and since June of this year the man has been perfectly well and continuously employed.

In September 1915 a young man of twenty with an unusually good family history while work

ing in a munition factory was passing a press which was operated by a lever not unlike a pump handle. As he passed under this lever it fell striking him on the crown of the head. He ducked his head with the remark, Gee, hut that hurt! and then continued with his work. At suppertime that night he told his sister of the accident saying that he had nearly been killed. The sister then forgot the incident for a period of thirteen weeks. The man continued at his work for six weeks and nothing unusual occurred during this period. He then began to complain of headache and said his eyes troubled him. He was sent to an oculist who made an appointment for him which he failed to keep. He began to show mental impairment and went from bad to worse, until at the end of thirteen weeks from the date of the injury he was absolutely demented. An alienist of more than average ability examined him and failing to get a history of an injury to the head, made a diagnosis of dementia præcox. Two other physicians appointed by the court examined him and recommended his commitment to the insane hospital. These papers were duly filed but owing to the fact that it was a busy Saturday the Judge did not sign the papers. The following day at breakfast the sister for the first time recalled the story of the accident and told it to her father. I was asked whether there could be any possible connection between the trifling accident and the present condition of dementia. The injury itself left no outward mark at the time it occurred. The scalp was not lacerated nor visibly contused, and there was no headache.

Having in mind the first case reported it seemed altogether probable that the trivial accident had caused a serous meningitis and that the mental impairment was the result of interference with the circulation of the brain. On this theory I made a subtemporal decompression, evacuated four ounces of cerebrospinal fluid of ordinary appearance. I introduced a drain beneath the brain and closed the wound. During the succeeding days following the

operation, there was a gradual return to consciousness and at the end of ten days the recovery was practically complete.

At my suggestion the patient wrote a postcard to my friend the alienist telling him he was making a nice recovery and hoped that he would call and see him before he left. The alienist who was present at the operation at my invitation called me up the following day and asked how the man was getting along. In answer to the question as to whether he had received a postcard from him he said Yes but some one else wrote it for him. No said I he wrote it himself.

The case is reported thus fully because there are in it elements of importance. It was unfortunate that the oculist the man consulted did not have time to examine him immediately. He surely would have seen tortuous veins in the fundus and would have prevented by an early decompression the subsequent insanity.

The case is noteworthy also in showing that a blow which left no visible evidence and no immediate disability could so contuse the membranes of the brain as to produce an extensive serous effusion. Until we know what the factors are which control the secretion of the cerebrospinal fluid and the pressure it exerts in the closed dural sac we shall do well to recognize that it may cause serious and fatal pressure. All cases will not react alike. There are some cases however which show a predisposition to meningeal irritation and these must be differentiated and early relieved by decompressive measures.

# STUDIES IN CLINICO-PATHOLOGIC STANDARDIZATION AND EFFICIENCY<sup>1</sup>

## I. LEGITIMATE ACTUAL ERROR IN DIAGNOSIS OF MAMMARY CONDITIONS

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From the Mayo Clinic

A COMPARATIVE examination of the clinical and pathological diagnoses in the following series of 1800 mammary pathological conditions operated upon in this clinic reveals certain items in medical efficiency of value from several standpoints

### NUMBER OF PATHOLOGICAL DIAGNOSIS

Clinical Diagnosis	Carcinoma	Fibroadenoma	Intraductal adenoma	Chronic mastitis	Cyst	Total
Carcinoma						16
Epididymitis (Carcinoma?)	90			18		108
Sarcoma						1
Adenoma		14				14
Fibroadenoma	5	58			4	79
Intraductal adenoma			1			1
Fibrosis						1
Cyst adenoma		1				1
Tumor	44	1	12	18	40	115
Breast	0					0
Breast?						1
Scalder						1
Cyst	6					6
Cyst?						1
Chronic mastitis		14		10		24
Chronic mastitis?				1		1
Epithelioma						1
Ulcus						1
Tuberculosis						1
Abscess						1
Myxoma						1
No diagnosis	70			70		140
Total	211	74	70	78	111	534

This table presents the following detailed facts

### PERCENTAGE OF ACTUAL ERROR

	Total Percentage
Mammary carcinoma diagnosed in the surgical laboratory	823
Mammary carcinoma diagnosed benign by the clinician	41
Mammary carcinoma not positively diagnosed by clinician	70
Clinical diagnosis of carcinoma in series	763
Clinical diagnosis of carcinoma which were incorrect	174
Chronic mastitis diagnosed in the surgical laboratory	174
Chronic mastitis diagnosed malignant condition by clinician	14
Clinical diagnosis of chronic mastitis which were incorrect	7
Clinical diagnosis of chronic mastitis which were correct	167
Fibroadenoma diagnosed in the surgical laboratory	9
Fibroadenoma diagnosed malignant condition by clinician	170
Clinical diagnosis of fibroadenoma	179
Clinical diagnosis of fibroadenoma which were malignant condition	1
Cyst diagnosed in the surgical laboratory	11

Cyst diagnosed carcinoma or sarcoma by clinician	1	6
Clinical diagnosis of cyst	17	
Clinical diagnosis of cyst which were carcinoma	0	16
Clinical diagnosis of adenoma	14	
Clinical diagnosis of adenoma which were carcinoma	0	
Clinical diagnosis of fibroadenoma	79	
Clinical diagnosis of fibroadenoma which were carcinoma	0	6
Clinical diagnosis of benign	1	
Clinical diagnosis of benign which were carcinoma	0	10

The actual error consists of a clinical diagnosis of a malignant condition when a benign condition really exists or vice versa. In these errors the indicated operation would be either too radical or not radical enough the patient would be a victim of too little or too much surgery. Such actual error from a clinical diagnostic standpoint is certainly inevitable and unavoidable from the nature of the pathologic conditions involved, especially since it is a physical impossibility always to differentiate benign from malignant conditions by any known clinical methods. The nature of certain advanced pathologic conditions in the breast are very evident to the experienced clinician but that there are conditions the diagnoses of which are certainly not evident is clearly revealed in the table presented above. These uncertain conditions are apparently more numerous than the ordinary professional impression seems to convey.

Legitimate as the error is from the standpoint of the insufficiency of signs symptoms, and clinical history it is absolutely illegitimate when viewed from the standpoint of surgical pathologists who unfortunately are painfully inadequate in quality and quantity in the hospitals of this and other countries.

In the past this inadequacy was unavoidable on account of a lack of operative surgery in early pathologic conditions the small number of pathologists to study early malignant conditions in association with inflammatory lesions and the scarcity of pathologists as a result of the rush of laboratory men into

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the fields of immunology serology and bacteriology and lastly the inadequacy of monetary and moral compensation sufficiently great to allow constructive energetic men of vision to spend their lives in this branch of medicine

Recent years have somewhat altered these circumstances. Surgeons by their own initiative and perfection of surgical technique have opened a new field for the pathologist who happens to be especially interested in the immediate clinical aspect of efficiency in therapeutics and fresh tissue research. This field presents methods which give to the surgeon during operations the same type of service which range finders give artillerymen in battle. During operative procedure accurate gross and microscopic diagnoses may be given to the operator in from fifteen seconds to three minutes during which time no operation can be completed and no extra material risk is added to the duration of the anesthesia.

In one organ alone i.e. the breast one may see efficiency in one item which in itself is positive proof of the valuable service rendered by the modern fresh tissue surgical pathologist. This item consists of the fact that out of 933 mammary carcinomata the surgical pathologist discovered during operation 211 (22

per cent) carcinomata which the clinician and surgeon had diagnosed benign or doubtful conditions. Only positively recorded clinical diagnoses are included in this number.

The practical surgeon today however is beginning to learn that clinical diagnoses in the breast are frequently not positive. When the surgical pathologist picks up 22 per cent of the total mammary carcinomata by means of his special training and methods he renders a service of supreme value not only to the surgeon but to the patient.

The question which arises from these facts is: Can surgical work be done on this organ efficiently and justly without such assistance? The answer is evident in the figures presented in this paper and one strongly suspects that what has been termed the legitimate error becomes an illegitimate error without such assistance. This statement may appear to be too radical in view of the fact that enough men especially trained in surgical pathologic diagnosis are not available to supply all of the hospitals. This does not alter however the truth relative to surgical and clinical efficiency.

An extensive and wordy dissertation upon this question could not emphasize this truth to any greater advantage than the figures themselves.

## II. THE APPARENT ERROR IN THE DIAGNOSIS OF MAMMARY CONDITIONS

In the first article of this series a comparative analysis of the clinical and pathological diagnoses of 1800 operative pathologic mammary conditions was made from the standpoint of the legitimate actual error in clinical diagnoses. It was pointed out that while there is a definite clinical error dependent upon inadequacy of clinical methods this legitimate error becomes illegitimate from the standpoint of justice to the patient simply because such error might be avoided by the utilization of properly trained surgical pathologists in immediate conjunction with operative procedure.

While the apparent error is not of such serious moment to the patient, it occurs in a much

higher percentage of clinical diagnoses than does the actual error. It consists of calling a benign condition by the name of another benign condition or a malignant condition by the name of some other malignant condition. In neither case would the error in nomenclature change the operative procedure and therefore would not cause the patient to undergo any unnecessary radical or insufficient treatment. It is of interest and importance only from the standpoint of efficiency of nomenclature in the transference of thought from one scientific individual to another.

Any business or military code with an error of from 8 to 50 per cent would not be tolerated and still the medical profession which is



striving for scientific efficiency utilizes such a code. The following figures represent the facts for one organ i.e. the mammary gland

	Total Percentage	
	Number	
Chronic mastitis diagnosed by the surgical laboratory	76	
Chronic mastitis diagnosed fibro-epithelial neoplasia	3	8
Clinical diagnosis of chronic mastitis	96	
Clinical diagnosis of chronic mastitis which were fibro-epithelial neoplasia	34	7
Fibro-epithelial neoplasia diagnosed in the surgical laboratory	170	
Fibro-epithelial neoplasia diagnosed chronic mastitis	44	
Fibro-epithelial neoplasia diagnosed some other benign condition	39	8
Cysts diagnosed in the surgical laboratory		
Cysts diagnosed in fibro-epithelial neoplasia		
Clinical diagnosis of cyst	3	
Clinical diagnosis of cyst which were fibro-epithelial neoplasia		
Clinical diagnosis of cyst which were chronic mastitis	10	84
Clinical diagnosis of adenoma	14	
Clinical diagnosis of adenoma, both cist chronic mastitis		
Clinical diagnosis of adenoma which are fibro-epithelial neoplasia	44	90

In this series the following nomenclature was utilized by the clinicians.

Adenoma	Gross (4)
Adenofibroma	Lipoma
Lipoma	Lump
Benign	Mycosis
Cyst	Mere
Carcinoma	Malignant
Chronic mastitis	Nodule
Cystic fibro-adenoma	Necrosis
C. at adenoma	No diagnosis
Cystic degeneration	Papilloma
Fibroma	Plecy
Fibro-adenoma	Reticular cyst
Sarcoma	Sclerosing cyst
Fibro-sarcoma	

Purely pathologic terms utilized by the clinicians.

These names were applied to the following pathologic conditions

Adenofibroma	Fibrosarcoma
Adenoma	Fibrosarcomatous
Adenofibrosarcoma	Fibrosarcoma-adenoma
Adenoma	Intra-vascular fibrosarcoma
Adenofibrosarcoma	Intra-vascular fibroma
Adenoma scirrhus	Intra-vascular fibro-adenoma
Benign	Intra-vascular adenofibroma
C	Intra-vascular papilloma
Cystic fibroma	Intra-vascular fibrosarcoma
Cystadenoma	Intra-vascular papilloma
Chondrosarcoma	Intra-vascular myofibrosarcoma
Cystic fibro-adenoma	Intra-vascular papilloma
C. at adenofibroma	Intra-vascular adenofibrosarcoma
Carcinoma tumor	Intra-vascular fibro-adenoma
Chronic mastitis	Intra-vascular myofibrosarcoma
C. etc. intra-vascular papill	Intra-vascular papilloma (malignant)
Lipoma adenofibroma	Lipoma
Cystic adenoma	Myofibrosarcoma
Carcinoma intra-vascular adenofibroma	Myofibrosarcoma
Carcinoma	Myofibrosarcoma
Dermoid	Myofibrosarcoma
Embryoma	Myofibrosarcoma
Fibro-adenoma	Myofibrosarcoma
Fibroma	Myofibrosarcoma
Fibrosarcoma	Myofibrosarcoma
Fibrosarcoma	Myofibrosarcoma

Pathologic terms not utilized by the clinicians

In utilizing this nomenclature the following errors were made

Pathologic Diagnosis	Clinical Diagnosis
Diffuse lipoma	called chronic mastitis
Cyst	called fibro-adenoma
Fibro-adenoma	called adenoma
Fibro-sarcoma	called carcinoma
Adenofibroma	called fibro-adenoma
F. fibro-adenoma	called reticular cyst
Fibro-adenoma	called adenofibroma
Adenofibroma	called carcinoma
Fibrosarcoma	called fibroma
Cystic fibro-adenoma	called myoma
Adenofibroma	called chronic mastitis
Cystic fibro-adenoma	called carcinoma
Cyst	called carcinoma
Fibro-adenoma	called carcinoma
Intra-vascular fibroma	called carcinoma
Lipoma	called cyst
Papillary fibrosarcomatous	called adenoma (early carcinoma)
Cyst	called cystadenoma
Fibro-adenoma	called carcinoma
Cystadenoma	called carcinoma
Adenofibroma	called fibroma
Intra-vascular papilloma	called chronic mastitis
Intra-vascular fibro-adenoma	called fibroma
Fibrosarcoma	called carcinoma
Intra-vascular fibro-adenoma	called carcinoma
Adenofibroma	called carcinoma
Intra-vascular fibro-adenoma	called carcinoma
Intra-vascular fibro-adenoma	called carcinoma
Myoma	called carcinoma
Intra-vascular adenofibroma	called carcinoma
Cyst	called carcinoma
Adenofibroma	called carcinoma
Lipoma	called carcinoma

These facts vivid as they are mean something to an analytical mind which is dealing with scientific efficiency and from them the following generalization may be logically made. The medical profession is trying to adapt detailed pathologic nomenclature and terminology to conditions which do not always reveal their detailed characteristics through signs and symptoms. This usage on the part of clinicians has been the logical outcome of the natural evolution of our knowledge of medicine but the evolution should not stop at this stage. Efficiency demands, at least an attempt at correction.

Experience with this series of cases has taught that the clinicians and surgeons really desire certain fundamental facts in so far as the patient is concerned they want to know whether the condition is benign or malignant and whether it is operable or inoperable. These are the essential factors which the practical surgical pathologist must face with the clinicians and surgeons. Detailed names play a very small rôle in the rendition of his assistance in such conditions.

It has been urged by some surgeons who have had some training in pathology that

they should be able to make their own gross diagnoses. This is ideal and possible if surgeons would spend time enough in learning pathology. Six months a year or five years of training in gross pathology will not keep a surgeon from making a high percentage of error in gross diagnoses.<sup>1</sup> It must be fully realized by the medical profession that in many conditions a microscopic diagnosis is absolutely necessary. This requires special training and experience far beyond that which can be obtained in the regular medical course or during internship in a laboratory or perhaps a course abroad.

Nomenclature and classifications which have been made by excellent surgeons who were poor pathologists have been largely responsible for much of the chaos in clinical pathology. Synonyms and classifications are almost as numerous as textbooks. There are apparently no signs symptoms and clinical histories which will positively differentiate any of the following conditions: adenoma, adenofibroma, cystic fibro-adenoma, cystadenoma, fibroma, fibro-adenoma, myxoma, lipochondrofibroma and fibromyxoma. And still the clinicians and surgeons continue to utilize such terms in spite of their cognizance that the clinical differential diagnosis is impossible by any known methods.

The clinicians in this series of cases have automatically shown evidence of the inefficiency of such usage and have substituted in their practice during recent years the terms

<sup>1</sup> In a series of consecutive examinations of 58 surgical specimens by the writers, it was absolutely necessary to make microscopic diagnoses in 39 per cent.

benign tumor growth lump nodule and mass. To them these terms are practically synonymous and do not describe a detailed microscopic condition which they cannot see. This is a hopeful sign for scientific efficiency in medicine.

In this series of cases the clinicians refrained from using such terms as

Intracanalicular—

Myxoma

Fibroma

Fibro-adenoma

Adenofibroma

Papilloma

Fibromyxoma

Adenomyxoma

These neoplasms however form a group which constitutes a much higher percentage of benign solid tumors of the breast than do the fibromata, adenomata, adenofibromata, fibro-adenomata, cystadenomata, myxomata and fibromyxomata terms with which the clinician is perhaps much more familiar.

The percentage of error in terminology is greatest in the benign group of conditions. From a standpoint of clinical efficiency these mistakes represent only an apparent error and certainly do not reflect upon the clinician's ability to render scientific service to his patients.

The names sound well but what is needed and demanded today is clear concise accurate and simple scientific medical practice which can be expressed in a clear concise accurate and simple scientific clinico-pathologic terminology and nomenclature.

### III THE AVOIDED ERROR IN THE DIAGNOSIS OF MAMMARY CONDITIONS

In the first two papers of this series the legitimate and apparent errors in clinical diagnosis of 1800 mammary pathologic specimens were considered. It was pointed out that the legitimate error becomes an illegitimate error when surgery of the breast is not accompanied by the immediate assistance of microscopic diagnosis and that the apparent error while of no great importance from the patient's standpoint is a result of

a clinically inefficient pathologic nomenclature.

The third type of error in this series has been called the avoided error by which term is meant that error which did not occur simply because the clinician utilized some doubtful or non specific nomenclature such as carcinoma? benign? malignant? chronic mastitis? cyst? sarcoma? tumor nodule growth, mass and no diagnosis and left the

actual diagnosis for the surgical pathologist to make

The frequency of such a clinical habit may be seen in the following percentages

	Total Number	Percentage
Mammary carcinoma diagnosed in the surgical laboratory	933	
Mammary carcinoma diagnosed possible malignant condition	96	
Clinical diagnosis of carcinoma?	3	
Clinical diagnosis of carcinoma? which were benign	0	
Clinical diagnosis of carcinoma? which were malignant	3	
Chronic mastitis diagnosed in the surgical laboratory	78	
Chronic mastitis diagnosed possible malignant condition		
Chronic mastitis diagnosed no diagnosis	25	6
Chronic mastitis diagnosed tumor	22	
Chronic mastitis diagnosed possible malignant condition, never visible or no diagnosis	16	42
Fibro-epithelial neoplasms diagnosed in the surgical laboratory	70	
Fibro-epithelial neoplasms diagnosed possible malignant condition		
Fibro-epithelial neoplasms diagnosed no diagnosis	36	
Fibro-epithelial neoplasms diagnosed tumor		
Cysts diagnosed in the surgical laboratory		
Cysts diagnosed tumor	40	40
Cysts diagnosed carcinoma?	7	14
Cysts diagnosed benign?		
Cysts diagnosed no diagnosis		
Clinical diagnosis of tumor	30	3
Clinical diagnosis of tumor which were malignant condition	44	14
Clinical diagnosis of tumor which were benign condition	86	

Perhaps the most interesting feature in this group of errors is the fact that 42 per cent of the clinical diagnoses of "carcinoma" were actually benign.

Another interesting and important feature is the apparent realization on the part of the clinician that absolute diagnoses in the breast are not possible in a great many cases.

This realization may be seen in the frequency of avoided errors which consist of "carcinomata? 157 sarcoma? 4 tumor 295 benign? 6 nodule 8 cyst? 3, chronic mastitis? 4 and no diagnosis? 92 a total of 569 or 31 per cent of all diagnoses. Those figures certainly show a simple truth, i.e. that the present pathologic nomenclature is quite inefficient from a clinical standpoint and suggests the necessity of a more adequate nomenclature.

#### IV CLINICO-PATHOLOGIC NOMENCLATURE OF MAMMARY CONDITIONS

In the first three papers of this series it has been clearly shown that an analysis of 1800 mammary pathologic conditions from the comparative standpoint of clinical and pathologic diagnoses reveals certain diagnostic errors which prove at least three definite things

1. A legitimate actual error (1) of from 1 to 26 per cent.
2. An apparent error (2) of from 8 to 50 per cent.
3. An avoided error (3) of from 1 to 57 per cent.

Coincidentally with the determination of these percentages it was shown that 31 per cent of the clinical diagnoses of mammary conditions were made with a full recognition on the part of the clinician that a positive diagnosis could not be made. It was also shown that the actual or so-called legitimate error becomes an illegitimate error if not checked during operations by the immediate services of a well trained surgical pathologist.

The apparent and avoided errors signified one essential fact i.e. that the present pathologic nomenclature was inadequate

inefficient and unscientific when utilized for clinical diagnoses.

In view of these facts and the necessity for greater efficiency a simple clinico-pathologic nomenclature has been utilized successfully by the writer.

For the sake of convenience all pathologic conditions in the breast may be divided into encapsulated and non encapsulated (diffuse) conditions the history of which is dependent upon the reaction of the component tissues of the breast regardless of the irritative or destructive agencies.

It has been shown in the breast and other organs that the aggregations of specialized and differentiated cells which we call tissues react to irritation in certain ways. Under certain conditions the tissue cells are rapidly or gradually destroyed and there is a successful or unsuccessful attempt on the part of nature at their replacement or regeneration. The success of this attempt means healing and the unsuccessful gradual attempt is associated with the following histological pictures dependent upon the quality quantity and duration of action of the destructive agent.

1 Primary cytoplasia when the differentiated tissue cells are present plus an hypertrophy of the regenerative cells of the tissues

2 Secondary cytoplasia when the differentiated cells have partially or completely disappeared plus an hyperplasia of the regenerative cells

3 Tertiary cytoplasia when the hyperplastic regenerative cells have migrated into the surrounding stroma (4)

An unsuccessful attempt at replacement and regeneration in the presence of any acute virulent destruction such as pyogenic infections results in abscess or necrosis and destruction of the whole organism. An unsuccessful attempt at replacement and regeneration in the presence of chronic non virulent tissue destruction results in a neoplastic hyperplasia of the regenerative cells of one or more of the tissues without their complete differentiation into tissues or the eventual destruction of the whole organism. It is this neoplastic hyperplasia with or without subsequent differentiation into tissues which is of importance in chronic mastitis and benign and malignant new growths.

It is self-evident that a new growth of cells benign or malignant must grow from something and that the cells of any tissue which is capable of growth are the regenerative cells. In the epithelial tissue of the breast these lie between the columnar or cuboidal secretory cells and the stroma. In the connective tissue the regenerative cells are the fibroblasts. In the presence of a chronic destruction of either or both of these special tissues there is an hypertrophy of the regenerative cells. This hypertrophy is often associated with or followed by hyperplasia and sometimes by migration.

In the condition of hypertrophy there is no evidence which warrants a suggestion of clinical malignancy because practically all chronic mastitides present this picture and every clinician and pathologist knows that all chronic mastitides are not associated with either benign or malignant neoplasms.

In the condition of hyperplasia of the regenerative cells the problem of malignancy or benignancy becomes more difficult because the hyperplastic regenerative cells are fre-

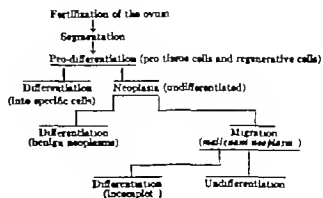
quently morphologically identical with malignant cells but are still within the normal bounds of their specific tissues (5)

Who is there who has the power to say whether these growing cells will be brought back to their normal power of differentiation by means of normal tissue control or continue to grow and migrate into neighboring and distant tissues and become malignant?

In so far as the clinician pathologist and patient are concerned this is an indeterminate condition which definitely forms a histological line of demarcation between that which is definitely benign and that which is malignant.

The biological history of the evolution of these regenerative cells may be shown in the accompanying diagram in which there is represented segmentation of the fertilized ovum and the production of cells which either produce immediately the tissues or the regenerative cells which later become differentiated into tissues. When the cells which are produced in this stage of pro-differentiation become differentiated in the normal course of embryologic development, normal tissues and a normal organism result.

It has been shown that in adult life the regenerative cells which occur in the stage of pro-differentiation in the postnatal organism do sometimes become hyperplastic (secondary cytoplasia) that they produce new growths in which the tissues are differentiated and that they sometimes produce new growths which consist of undifferentiated migratory cells. The new growths with differentiation constitute the benign neoplasms. The new growths with migration and incomplete differentiation constitute the malignant neoplasms.



These facts are true not only of epithelial tissue but also of connective or fibrous tissue and perhaps all tissues. In benign fibro-epithelial neoplasms the condition of secondary and tertiary cytoplasia also sometimes occurs hence the presence of malignant conditions arising in the so-called fibro-epithelial neoplasms which are usually benign. In so far as the reaction of the tissues of the breast is concerned it matters not whether they are encapsulated or non-encapsulated they react in these three degrees to chronic destruction. Upon the degree of reaction will depend the life history of the breast and consequently the whole body of which the breast is a part. Biologically in these three stages we have cellular destruction cellular hypertrophy cellular hyperplasia and cellular migration.

The regenerative cells possess certain possibilities. They reproduce specialized differentiated tissue cells they reproduce themselves as undifferentiated cells and they migrate as undifferentiated cells. From a clinical standpoint in the condition of hypertrophy they are carrying out a normal communitistic existence i.e. producing a special tissue which is to work in conjunction with other special tissues of the multicellular organism. In the second condition they produce an indeterminate condition the end result of which cannot be prophesied by any known methods. In the third condition experience has taught us that the cells when they are in the stroma continue their migration even to distant organs grow and eventually destroy the life of the organism.

Regardless of whether we call a chronic inflammatory mammary condition chronic mastitis and benign tumors e.g. adenomata fibromata adenofibromata fibro-adenomata fibromyxomata myxofibromata myxomata or intracanalicular fibro-adenomata, adenofibromata myxomata adenomyxomata or any other names which have been given to the various conditions or whether we call a condition Schimmelbusch's disease Reclus's disease abnormal involution senile parenchymatous hypertrophy or any other of the 10 or 12 synonyms or whether we call carcinoma scirrhous adenocarcinoma comedo-

carcinoma or carcinoma simplex or any other name the fact relative to the conditions which are present remains simply one of reaction on the part of the cells involved and so far as the clinical surgical, and pathological experience of the writers has been concerned the patient's welfare depends absolutely upon a decision as to whether the cytologic activity is benign indeterminate or malignant. The names of tumors play no great rôle. The nomenclature as it exists in textbooks does not produce a clear conception of what actually exists from the clinical standpoint. It is true that neoplasms are grouped in textbooks into benign and malignant and under each group there is a long list of names of conditions which have been described in detail from the pathologists' standpoint but that this detailed description with its nomenclature has been of great efficiency to the clinician may be answered in the negative from the experience in this clinic. A glance at the percentages of error which has been made during the utilization of and on account of the present textbook nomenclature is sufficient to support the statements made above.

In summarizing the writer's solution of this problem it may be stated that the main object is the proper treatment of the patient which may be best accomplished by a simple realization of the fundamental facts that the history of the breast is the history of its tissues in their battle against irritants and destructive agencies of any kind and that all tissue cells react in certain ways to these agencies depending upon the quality quantity and duration of action. The histologic pictures of this reaction represent tissue destruction tissue replacement cellular regeneration, cellular neoplasia and cellular migration.

Clinical experience has taught that destruction of tissue cells may be complete and fatal to the organism or it may be incomplete and the destroyed tissues be replaced or regenerated. It may be incomplete and still great enough to prevent complete replacement or regeneration during which a new-growth (neoplasia) occurs the cells of which may become differentiated and are benign or remain undifferentiated migrate and are malignant. These

are the clinical effects of reaction and it is these simple effects which should be borne in mind by the clinician surgeon and pathologist regardless of the name of the tumor.

The conditions of the tissues are really what the clinician desires. From this by correlation with clinical experience he may decide upon the benignancy or malignancy, the degree of treatment, and the future of the patient.

It may be definitely stated by a pathologist familiar with the stages of tissue reaction that there exists primary secondary or tertiary cytoplasm which have three definite clinical meanings regardless of names of tumors which do not always have definite clinical value. If the clinician or surgeon desires still to group his conditions into encapsulated and non-encapsulated then he is dealing with

Encapsulated or Non-encapsulated	<table> <tr> <td>Primary</td><td rowspan="3">} Cytoplasm</td></tr> <tr> <td>Secondary</td></tr> <tr> <td>Tertiary</td></tr> </table>	Primary	} Cytoplasm	Secondary	Tertiary
Primary	} Cytoplasm				
Secondary					
Tertiary					

His error then becomes dependent simply upon his ability to determine by signs symptoms and clinical history whether he thinks a condition is benign malignant or doubtful. The tissue involved and the degree of involvement can only be decided by the surgical pathologist and this decision can be made during operations without added injury to the patient provided the lesion is excised instead of incised.

At this juncture clinicians will doubtless say that there are so many cases which are quite evident. True as this is there still remains a 5 per cent error in the diagnoses of carcinoma and a failure to discover 22 per cent of carcinomata. These percentages demand the

immediate service of the laboratory. If the plan set forth in this series of papers be adhered to the 5 per cent and 22 per cent will be done away with the apparent error of 8 to 50 per cent will completely disappear and such non-descriptive and unscientific terms as mass tumor nodule, and growth and names of tumors with question marks will not be necessary in clinical diagnoses.

The medical code for pathologic conditions in the breast will be transformed from one of inefficiency to one of scientific efficiency and the patient will reap the benefit.

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EXTERNAL RUPTURE OF A PELVIC HÆMATOMA DURING INSTRUMENTAL DELIVERY<sup>1</sup>

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THIS case occurred in the outdoor obstetrical service of the New York Post Graduate Hospital and is of especial interest in that it is apparently the first case of hæmatoma in the literature complicating the second stage of labor.

Mrs. M., age 38, VI para. *Previous history* One miscarriage and two stillbirths at term from mal-presentation of foetus and perverted delivery. *Menstrual history* of no significance. *Physical examination* showed heart and lungs normal. The patient was obese with a large relaxed and pendulous abdomen.

*Pelvic measurements* Interspinal, 26 centimeters; intercrural, 20 centimeters; right oblique, 3 centimeters; left oblique, 23.50 centimeters; external conjugate, 2 centimeters. *Promontory* not felt. *Outlet* was roomy. *Presentation* was vertex. *Position* L. O. A. *Due* February 14, 1907.

Labor began at the home of the patient at 7 a.m. February 13. The first stage was normal lasting thirteen hours. The second stage began at 8.30 p.m. with the rupture of the membranes and fairly strong bearing down pains. The uterine contractions, however, gradually subsided in force and frequency and with complete dilatation of the cervix a cubic centimeter of pituitary extract (Armour's) was injected intramuscularly in two doses at five minutes intervals. This had no apparent effect upon the pains.

After two hours in the second stage, with diminishing of uterine contractions and no advance of the presenting part, and as the foetus seemed large and was overterm, it looked at the time to be a straight case of uterine inertia with indications for a forceps delivery. The head was in the brim of the pelvis in the L. O. A. position. Both maternal and foetal hearts were in good condition. No masses were felt by vagina. With the patient on a kitchen table and placed in the lithotomy position the vulva was prepared as usual and chloroform anesthesia given. The solid blade forceps was first tried and several attempts made to introduce them to secure an application to the sides of the foetal head, but the second blade would not be rotated opposite the first posterior blade. Traction, however, was made with the blades in the oblique application, with slipping of the blades.

A change was then made to the axis traction instrument. The same difficulty in application was encountered here so traction was made with blades in the oblique application. Strong inter-

mittent traction was made for one hour with very slow advance of the head. As the head appeared on the perineum and when further traction was exerted to deliver it a gush of dark clotted blood was propelled with great force from the introitus, striking the operator on the left shoulder. After this apparent rupture of some structure, the head was easily delivered over the perineum. The birth of the shoulders and the rest of the body was readily effected. The child was moderately asphyxiated but cried on spanking. There was however a right-sided facial paralysis. The child weighed 10 pounds, 4 ounces. On examination of the vulva to ascertain the amount of damage done, and the origin of the hemorrhage, a vertical external laceration about 3 centimeters long was found to exist at the upper angle of the anterior and left vaginal walls and labium minus close to the pubic ramus, and from which a slight oozing of blood was seen. Thinking of a possible ruptured uterus, the gloved finger was introduced into this opening for exploration. It was found to lead into the cellular tissue outside of the vaginal walls and into a cavity extending upward alongside of the cervix and lower uterine segment and base of the left broad ligament about 1 centimeter from the vulva. On further examination the finger came in contact below with the posterior surface of the pubis and anteriorly in the median line with the neck of the bladder. The uterus and bladder were found intact. The patient was in considerable shock by this time—the pulse being 150 and the body and face pale and perspiring freely. The cavity was packed with eight yards of 1½ inch iodol form gauze with cessation of the bloody oozing. Procedures were then established to combat shock, from which the patient rallied in short time. On the following morning the pulse was 100 and temperature 99°. It was necessary to empty the bladder per catheter for three days. The temperature did not go above 100 at any time and the pulse gradually came down to normal. The packing was partially removed on the second and third day and completely by the fifth day. The cavity gradually filled in and was completely healed on the twelfth day postpartum. The child developed stupor and refused to nurse on the third day. Spasms of lips and left eyelid and later nystagmus developed with its death on the fifth day apparently from a meningeal hemorrhage.

The unusual condition of the mother was evidently due to an unrecognized pelvic hæmatoma formed during the first stage of labor in the cellular tissue at the base of the broad ligament sub-peritoneally and above the pelvic fascia. The

collection of blood was not of sufficient amount (estimated at about 4 5 to 5 ounces) to cause an acute anemia but large enough to prevent the advance of the head with normal uterine contractions and to prevent the proper application of the blades of the forceps. As forcible traction was made, and with the advancement of the head the hematoma was forced downward dissecting its way through the cellular tissue covering the pelvic floor and reaching the pubic ramus it was deflected laterally until arrested by the foetal head and then toward the median line and there arrested by the anterior ligaments of the bladder. The strong fascia covering the levator ani muscle prevented its making its way posteriorly so being forced downward by the advancing head, rupture externally occurred through the inferior triangular ligament under the descending ramus of the pubis.

In reviewing the literature on this subject it was found that Dr Williams of Baltimore had collected 33 cases of subperitoneal hematomata including one of his own. Since that time other cases have been added to these.

As regards the etiological factor in these cases the bleeding has been found to emanate from the capillaries at the base of the bladder instead of the larger vessels. The small vessels are separated from their attachments

by the traumatism in the advancing of the presenting part and later rupture causing a gradual accumulation of blood in the cellular tissues. Williams in his case which came to operation, found only a capillary oozing from the inferior and superior surfaces of the bladder which was controlled by packing. In Perret's case which was autopsied it was proved by injecting the vessels that the larger ones were intact and that the bleeding came from the capillaries.

I might say that the majority of cases reported were hematomata that became apparent following delivery and so far I have not ascertained any that complicated the second stage of labor. In this case if the hemorrhage in the cellular tissue had not obstructed the advance of the presenting part making it necessary for an operative delivery it is a matter for conjecture whether the collection of blood would have increased postpartum and given rise to symptoms of internal hemorrhage and signs of a tumor mass which according to the urgency and size of the hemorrhage would have required operative measures for its relief.

## A PRIMARY MALIGNANT NEOPLASM OF THE FALLOPIAN TUBE, PROBABLY DECIDUOMATOUS

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**P** RIMARY malignant neoplasms of the fallopian tubes are seen sufficiently infrequently to warrant the reporting of another case. The most commonly encountered neoplasms are the carcinomata. Of these, Vest (1) in 1914 reported 132 cases. Lipshitz (2) in the same year had collected 144 cases to date but considered that many of these were not acceptable because of the lack of microscopical verification of the diagnosis. Tchernac (3) 1914 mentions many of the same cases referred to by the above authors, and in addition 10 or 12 other cases. Other isolated cases are reported by Cumston (4) Levitski (5) Karakoz (6) Cesar (7) Forsner

(8) and Gurd (9). It is possible that some of these reported carcinomata have not rightly belonged in this group. LeCount (10) selected 21 out of 52 cases that had been reported up to 1901 excluding 15 because of insufficient data and 37 as papillomatous growths known to be due to inflammation. The danger of confusion is discussed by Kraus (11) in an article on the carcinoma like epithelial growths in the tubes bringing out the point that papillomatous outgrowths of the mucous membrane are frequently associated with inflammatory conditions here. Voigt (12) reports a case of carcinoma like growths associated with tuberculous salpingitis.



Primary deciduomata and sarcomata are still more rarely seen. Duénu and Longuet (13) found references to only one primary deciduoma of the tube and six sarcomata (3 other cases however being classified as mixed tumors) in the literature to 1901. We have found no other cases reported as tubal sarcoma to date. In 1905 Risel (14) collected 11 cases of primary tubal deciduomata out of 300 reported cases of chorio-epitheliomata. Proust and Bender (15) refer to one by Lolquist (1909), Cope and Kettle (16), Bazy (17) (1913) and Hugnier (18) each report another making a total of 15 cases. Sarcomata and deciduomata of the ovaries are not included among these. Of these tumors the carcinomata have been the more completely analyzed. Etiologically previous inflammation has been generally held as the most frequently provocative factor. However in the literature as reviewed by Vest possible infection had been found in 57.7 per cent of cases and in 42.3 per cent there was no history of infection. On the other hand there have been only 4 cases of primary carcinoma of the tubes among the 19,000 cases of infected tubes seen in Johns Hopkins Hospital. The age at which carcinoma attacks the fallopian tubes corresponds to the usual so-called cancer age; the majority of cases occurring between 40 and 50 years, the youngest patient on record being 27 years old, the oldest 70.

Pathologically these tumors have been found to be characteristically papillomatous. Sanger and Barth (19) classify them as papillary and papillary alveolar. Friedenheim (20) as papillary and papillary alveolar mucous membrane carcinomata and alveolar wall carcinomata. Falk (21) speaks of the benign papillomata, the malignant papillomata and the papillary epitheliomata. None of these authors seems to have noted any other form in this tissue, in fact any form which did not in some place show a distinctly papillomatous arrangement. As the growth enlarges, the tube becomes filled and distended, the walls may thicken or be stretched thin and may be invaded but are rarely perforated. These tumors are regarded as highly malignant but of rather low growth before symptoms are pronounced (Vest). Direct implantation on

the peritoneum is frequent and in location sometimes suggest the path of transmigration of the ovum.

The chief symptoms as outlined by Vest (1) include discharge, pain and abdominal distention. The discharge may be leucorrheal or as is more characteristic, blood tinged, copious, continuous or in periodic gushes and usually acid or malodorous. The pain is frequently colicky and usually localized in one of the lower abdominal quadrants but may radiate to the upper abdomen, back and legs. Later it becomes constant and severe. The abdominal distention or tumor is sometimes the first symptom complained of and may extend up to the umbilicus. Menorrhagia and metrorrhagia are the menstrual disturbances noted and when these appear after the menopause, suspicion is aroused even though the uterus seems free from pathology. Curettings in such cases have been reported negative in several instances. The late symptoms include loss in weight, cachexia, ascites, and painful urination and defecation.

Malignancy following extra uterine gestation is characterized by symptoms as illustrated by Bazy's case: a period of amenorrhoea with an abdominal tumor growth and associated with emaciation, anaemia, and pain, the enlargement being found to be attached to one side of the uterus.

#### REPORT OF CASE

The patient, a Polish woman, age 30 and single, a domestic by occupation, entered Cook County Hospital, March 8, 1915, complaining of abdominal pain. The history as obtained through an interpreter was that following a period of amenorrhoea of two months (though always menstruating regularly before) and 2 weeks before coming to the hospital, she suddenly began to have severe pain, especially on the right side of the lower part of the abdomen. She had chilly sensations and vomited several times with the onset of this pain. The pain had been more or less continuous throughout the two weeks but seemed to be decreasing in severity. There were no urinary difficulties nor was there any vaginal discharge. Upon examination the patient appeared rather pale, fairly well nourished, complaining very little, but seemed acutely ill. There was a mass occupying most of the lower right quadrant of the abdomen. It was moderately tender but associated with little muscular rigidity. Upon vaginal examination, the uterus was found to be displaced anter-

orly ad to the left the cervix being flattened against the symphysis. The temperature ranged from 98.6° to 104 and the pulse from 120 to 140 during the first 36 hours of her stay in the hospital. The leucocyte count was 22,000. The diagnosis of infected extra-uterine pregnancy was considered the most probable.

An operation was performed by Dr. R. T. Vaughan and disclosed a large friable bloody mass to the right and back of the uterus. The condition was interpreted as an ectopic pregnancy in the right tube which had ruptured some two weeks before into the broad ligament, dissecting apart the layers of peritoneum. Masses of soft material here and under the peritoneum back of the uterus were regarded as old blood-clots undergoing absorption and septic degeneration. There were about eight ounces of free blood in the peritoneal cavity some appearing to ooze from the open fimbriated end of the right tube. The left tube was edematous and many dense adhesions were present involving the tubes and posterior wall of the uterus and the intestines and appendix. The base of this mass was so wide that clamping and excising were not attempted but the contents of the mass were shelled out and bleeding stumps containing the ovarian artery and anastomosing branches from the uterine were ligated, and a five yard gauze drain packed into the cavity the free end extending through the abdominal incision. For the next few days the patient was very ill and at the end of a week of continued temperature of 102 to 104, pulse 108 to 132 and leucocytosis of 20,000 a fluctuating mass was found in the posterior cul-de-sac and diagnosed as a pelvic abscess. A posterior colpotomy was performed and about one quart of foul bloody purulent fluid removed and a drain inserted. The patient continued a septic course, feet became swollen, urine showed albumin and casts and about a week before she died fresh blood was discharged through the posterior colpotomy wound, together with masses of tissue grossly resembling placental tissue. Considerable necrotic tissue with a very offensive odor was also passed. These hemorrhages and offensive discharges continued until the patient's death May first.

An autopsy was performed May 5, 1915. The following is a record of the gross findings.

The body was that of a small poorly nourished female. No icterus. Superficial lymph glands not palpable. There was a laparotomy wound about 9 centimeters long gaping about 4 centimeters to the right of the midline below the umbilicus with a floor made of the fascia of the muscles. The lower extremities were edematous especially the right. There was increased pigmentation of the areolae and hypertrophy of the mammary gland tissues but no milk.

In the abdominal cavity the peritoneum was everywhere blackened and tags of fibrous and fibrous adhesions were scattered through the cavity. Fat was very scant. In the dense adhesions present under the laparotomy wound was a pocket made up of necrotic pink masses with softened centers above

the umbilicus were two pink vascular masses 2 to 3 centimeters in diameter adherent to the omentum and in the adhesions between the intestines a few other similar but smaller masses. The entire pelvis was filled with a purulent mass of necrotic tissue and pus and some fecal material. Above this was bounded by the sigmoid and adhesions there being a small communication between the sigmoid lumen and the cavity, below there was an opening about 2 centimeters wide into the vagina behind the cervix. The wall of the cavity was formed by necrotic purulent tissue apparently derived from the pelvic connective tissue. The uterus formed part of the inferior surface.

The pleural and pericardial cavities were normal. The lungs collapsed well. A little fluid was present posteriorly to the lower part of the left lung slightly more than in the right. Very little anthracosis. Bronchi were filled with a mucopurulent normal bronchial lymph glands were not unduly enlarged. There were no areas of consolidation in the lungs and no tumor nodules.

The heart weighed 210 grams. Pericardium, myocardium, endocardium and valves were normal. Slight sclerosis was present at the beginning of the aorta. There was a recent laminated thrombus in the left common iliac vein but slightly adherent and terminating at the bifurcation.

The liver weighed 100 grams. Cut surface light yellow but the lobular markings not unduly conspicuous. Gall-bladder normal.

The spleen weighed 60 grams. Tissue normal.

There was a perforation of the sigmoid into the pelvic abscess but no other changes in the gastrointestinal tract.

The adrenals were small and poor in cortical substance.

The kidneys weighed together 300 grams. The left renal vein and its tributaries were occluded by a friable laminated thrombus. The smaller veins of the right kidney were thrombosed. The substance of the kidneys was very pale. The cortices light in color the capsule stripped easily leaving a smooth surface. The bladder was adherent to the uterus. The lining of the bladder normal.

Generative organs. The ovaries could not be found because of adhesions and necrosis. The left fallopian tube was hyperemic, edematous and had a 1 centimeter oodule of soft tissue. The uterus was close to the symphysis and the fundus was adherent to it. The cervix was increased in diameter. There was apparently no decidua in the cavity of the uterus, which seemed normal. The lymph-glands in general were normal.

The muscular system was not well developed but presented no abnormalities. The skeleton was normal, the bones of the pelvis were not eroded by the abscess.

The gross anatomical diagnosis was as follows:

Primary malignant neoplasm of the fallopian tube, infiltrating pelvic tissues. Pelvic abscess communicating with sigmoid flexure and vagina. Diffuse recent

fibrous and fibrous peritonitis encapsulation of the pelvic abscess by fibrous adhesions incompletely united laparotomy and encapsulated neoplastic masses in the peritoneum thrombosis of the veins of both kidneys recent thrombosis of the left common iliac vein edema of the lower extremities parenchymatous nephritis hypostatic edema of the lungs slight fatty changes in the liver extreme emaciation

Upon microscopic examination these masses of tumor tissue are found to be of peculiar structure the characteristic feature being the variety of cells present and the absence of definite arrangement. There is no papillary or alveolar arrangement to be found. The cells range in size from 5 to 30 microns.

epithelial in type have large round and oval nuclei 10 to 20 microns in diameter showing many mitotic figures. Some of the larger nuclei seem grouped together without demonstrable cell boundaries separating them. The larger cells especially are highly phagocytic containing red blood corpuscles leukocytes and blue staining bodies. There are also a few pink staining hyaline bodies oval in shape between and nearly as large as the cells. The blood content of the tumors is variable. Some parts have only a few red cells scattered between the tumor cells and in the places there are large spaces containing blood with and without endothelial linings separating them from the tumor cells. Connective tissue as brought out by the Van Gieson and Mallory stains is present in comparatively small amount and this is the most part as a capsule. In a section of the fallopian tube from the left side there is invasion from without by a cell mass resembling histologically the other tumor masses. This also is well encapsulated. There is present here also edema of the stroma occlusion of the lumen, erosion of the mucosa and moderate cell infiltration of the mucosa. Regional lymph glands and others are free from metastases. The wall of the uterus is edematous with slight necrosis of the outer portion of the wall but no tumor growths and no decidua formation. The wall of the pelvic abscess contains comparatively few leukocytes but many tumor cells.

To recapitulate we have here a patient 20 years old presenting history symptoms and physical findings suggesting an ectopic pregnancy and considered as such without question at the time of operation. Four weeks after the operation the patient died of hemorrhage and sepsis with a pelvic abscess perforating the sigmoid and opening into the vagina and thrombosis of the iliac and renal veins. Upon postmortem examination the wall of the pelvic abscess was found to be made up of extremely soft neoplastic tissue of peculiar polymorphous cells and encapsulated nodules of similar histological

structure were found implanted on the peritoneal surfaces, both parietal and intestinal, and invading the left fallopian tube. There were no metastases in the lymph-glands nor in remote organs as in the lungs. Grossly the isolated tumor nodules did not suggest syncytioma, being encapsulated and pale and not of the soft, ragged intensely hemorrhagic nature variegated in color generally characterizing this form of neoplasm. The pelvic growth was so much altered by infection that its characteristics had little significance. The rapidly destructive growth is evidenced by the erosions into the sigmoid and into blood vessels causing hemorrhages which almost exsanguinated the patient (possibly accounting for the pale appearance of the peritoneal nodules).

In studying other reports of malignant tumors of the tubes our attention is attracted to the fact that the carcinomata have all occurred in women of the so-called cancer age the youngest reported having been 27 years old. Also these have been characterized histologically by papillary or papillo-alveolar growth. (Sanger and Barth, 19 *Friedenheim*, 20 and Falk 21) Deciduomata on the other hand have been noted in younger individuals even as young as 17 years (Hugnier). Histologically where found deciduomata may be grouped into the typical atypical and intermediate forms typical showing Langhans cells (Schmauch, 9) as well as syncytial cells and masses or Langhans cells and intermediate having the epithelial cells and masses only. Of these the atypical is usually least malignant and has been regarded as a later stage of development of the other forms. These never become generalized whereas the majority of the typical malignant chorio-epitheliomata are generalized and many of the intermediate form have metastases in the lungs. They are all friable bloody and show a great tendency to invade tissues in contact, especially eroding and growing into blood vessels. Stroma and blood vessels within the tumors are usually inconspicuous or lacking and everywhere the tissue is torn and disarranged by hemorrhage (Schmauch)



Fig. 188 Showing general structure of the growth.



Fig. 189 High power magnification showing structure of prevailing cell types.  $\times 1000$

From the above accounts this tumor does not seem to possess the characteristics of carcinomatous neoplasms especially those of the fallopian tubes but rather resembles the atypical chorio-epitheliomata the large epithelial cells being syncytial cells in some places uniting to form small syncytial masses. No typical Langhans cells were found. On the basis of the clinical history operative and autopsy findings and histological structure we consider that in all probability the neoplasm arose in the decidua of an ectopic gestation although the histological findings alone are not sufficiently conclusive to prove positively that the tumor is a deciduoma.

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GIANT-CELL EPULIS OF UPPER JAW<sup>1</sup>

By FRANCIS RIDER M.D. S. LOUIS

An epulis is a tumor of the gum with a suspension. It is the most frequent of oral tumor. Its subdivision into fibroma and giant cell sarcoma characterizes it as a borderline lesion. Both the fibroma and the giant-cell sarcoma spring from the dental peristeme of the alveolar process or the connective tissue between the bone of the alveolar border and the mucous membrane of the gum surrounding the teeth (Bloodgood) either outside or inside the alveolus.

An epulis may also find its origin in the interior of a diseased tooth socket. Almost any part of the alveolar ridge may prove a suitable nidus for the development of this growth with a preference however being shown for the canine region over the bicuspid the bicuspid over the first molar and the first molar over the incisor (Scudder).

The variety of epulis known as a fibroma consists entirely of fibrous tissue. It is not a very vascular tumor and is usually of small size projecting between two teeth. It is well circumscribed.

Its growth is slow and the mucous membrane covering the tumor is usually normal in appearance. A fibroma does not metastasize nor does it appear to possess the definite characteristics of malignancy except for the suspicious action of recurring locally if not completely excised. If such a tumor is allowed to grow ulceration and necrosis from pressure of the teeth will eventually occur.

The giant cell sarcomatous epulis presents a somewhat different clinical picture. However it has some characteristics in common with the fibroma namely it rarely metastasizes, and usually remains a local lesion confined to the alveolar process until it is treated surgically. Any surgical measure that will fail in a successful excision will cause the tumor to recur often with surprising promptness. Under such conditions it is prone to form metastases. Although the tendency

to glandular enlargement and to form distant growths is rather remote a fact which robs it of the true character of a malignant neoplasm its rapid and destructive growth compels it to be classified with the malignant types of sarcoma.

A malignant epulis having a broad but more often a narrow attachment, usually appears at the edge of the teeth as a red soft and irregularly rounded mass. The deep pigmentation which characterizes this mass is caused by its great vascularity. Therefore it is not surprising that these tumors bleed easily upon slight trauma.

The appearance of the mucous membrane in the immediate vicinity of a giant-cell epulis gives little or no evidence of any infiltration. However if the growth should have its seat in the alveolar ridge of the upper jaw the likelihood of an infiltration involving the soft structures of the hard palate is not improbable. Very rarely is there an invasion of the bone by such a growth.

The consistency of a giant-cell epulis is not uniform. Although it imparts a spongy feeling throughout, certain parts of the tumor appear hard while others seem soft. In palpating such a tumor the sensation of touching a mass of granulation tissue is forcibly brought to mind.

A malignant epulis does not cause pain, except during the formation period when it is not easily recognized and is often mistaken for a gum boil. At that period a toothache or a neuralgic pain, for which the patient may or may not seek relief from a physician, is the only discomfort experienced. The contact of the tumor with the neighboring structures (except the teeth which are often pushed out of their sockets) does not in any way affect them.

Through its size an unsightly protrusion of the lip may be occasioned. The sulcus between lip and jaw as well as the one between cheek and jaw retains its normal anatomic characteristics. The well being of



Fig. 1



Fig. 2



Fig. 3



Fig. 4

Fig. 1. Giant-cell epulis of upper jaw

Fig. 2. Same case, lateral view

Fig. 3. Restoration of mouth after operation

Fig. 4. This photograph shows the security with which the patient could wear a palate plate with teeth after operation

an individual suffering with an epulis is not unfavorably influenced unless the size and location of the tumor interferes seriously with the partaking of food. Such tumors rarely ulcerate. Should ulceration occur it is more likely to be caused by pressure than by infiltration.

On account of the great vascularity of a malignant epulis obstinate bleeding often takes place. However bleeding never assumes the character of a hemorrhage. An epulis shows no predilection either for the upper or lower jaw both jaws being equally liable to the disease. Women seem to be more prone to the disease than men the ratio being about two to one. Age appears to have some influence the lesion appearing usually during childhood and young adult life.

The prognosis of an epulis when the proper surgical measure has been carried out, is good. The fibrous epulis when thoroughly removed never returns. The giant-cell variety however shows a marked tendency to recur and only then can the greatest promise of a cure be obtained when the growth together with the alveolar border has been removed.

Unfortunately the term sarcoma so often used in emphasizing the nature of a giant cell epulis has been responsible for much heroic operative work on the jaw some

of it perhaps necessary and some of it perhaps needless. In all lesions of a suspicious nature however it is a great satisfaction to know that the work of eradication has been carried well into the normal tissue. In quoting some statistics 18 cases at the Heidelberg clinic according to Wassermann resulted in 15 cures and 3 recurrences. Gunzert reports 38 cases — 35 well and 3 recurrences one death from metastatic sarcoma of the brain following extirpation of fibrosarcomatous epulis of the jaw. According to Bloodgood of 40 operations for epulis at Johns Hopkins Hospital clinic, all have remained well including the recurrent cases (Scudder).

The case of giant-cell epulis of the upper jaw that I wish to present is that of a woman 52 years of age. She is the wife of a farmer has never had any serious illness and is quite stout.

One morning in March 1913 while opening the chicken house a hen flew into her face striking her in the mouth and causing several teeth in the upper jaw to be loosened. About a month later she had a bad toothache. The ache continued. She consulted a dentist who extracted the tooth. This gave prompt relief. About two weeks after the tooth was extracted she noticed a swelling about her upper gum near the right eye tooth. A physician diagnosed it as a gum boil and lanced it. The gum boil did not disappear but slowly continued to grow. Inasmuch as it was not painful, she tried to forget it.

About six months later however the growth had assumed other proportions that she went to a physician who treated it. The tumor then was occupying the greater part of the gum of the upper jaw. Most of the teeth had become so loosened that they either dropped out or were easily extracted. The mass was cut away twice by the physician with the month. After that it was freely cut with nitrate of silver. Within two weeks the growth had returned and was growing rapidly.

When I saw the patient in December 1903 she was very much depressed over her condition. Her nervousness had robbed her of much sleep. She was unable to take food in liquid form. Her general health began to suffer.

Examination of the mouth revealed a venous-colored spongy mass about the size of a small nutting nut attached to the alveolar border of the upper jaw. It presented projections and irregularities on the surface and extended out the hard palate protruding under the upper lip which it pushed downward and out and

The mucous membrane of the alveolus was thickened somewhat soft and quite red. The teeth of the upper jaw were all missing having been lost during the growth of the tumor. The sulcus between lip and alveolar border was normal. No febrile discharge was present and the mass looked clean. The lower jaw possessed most of its teeth all in a poor state of preservation.

In removing the tumor the incision was made through the mucous membrane quite free of the tumor. With the chisel the whole of the alveolar border of the upper jaw was removed. Bleeding was very free. It was however readily controlled by pressure. The patient suffered no untoward effect from the operation, and made a quick recovery, nothing unusual happening during the healing process. Four months later she was able to be fitted with a palate plate with teeth which she is wearing with comfort.

It is now three years since the tumor has been removed. There is at present no evidence of any recurrence.

## UNILOCULAR CYST OF THE PROSTATE CAUSING OBSTRUCTIVE SYMPTOMS<sup>1</sup>

B. MOSES BENKEND, M.D., PHILADELPHIA

A UNILOCULAR cyst in the position of the embryonic ventral lobe may have as its causation a congenital basis. According to Lowsley the various parts of the prostate gland as seen in the fetus after the third month are the following:

The middle lobe or that part of the gland which is situated between the bladder and the ejaculatory duct and the floor of the urethra.

The lateral lobes or those parts of the gland which arise from the prostatic furrows and the lateral lobes of the urethra and extend laterally and posteriorly from that structure.

The posterior lobe or that part of the prostate gland which lies dorsal to the ejaculatory duct above the transverse line of the urethra and dorsal to the urethra below this point.

The ventral lobe or that part arising from the terio or ventral lobe of the prostatic urethra. The tubules in the terio lobe appear first as solid epithelial outgrowths and begin to develop about the same time as the tubules in the other parts referred to above. They are large and have numerous branches at first but in the sixteenth week they are slightly smaller than the tubules of the other lobes. At the twenty-second week these tubules have decreased in size and number and cry

few branches are noted. After the sixteenth week the anterior lobe is insignificant but the tubules persist after birth at which time there are found two very small tubules. Evidence of the fact that these tubules may persist in the anterior lobe has been found in 91 specimens.

Kunitzky quoted by Lowsley found a persistent ventral lobe in one out of fifteen prostates.

It is not impossible therefore that a cyst may be formed in one or both of the remaining tubules of the ventral lobe. In adults cysts of the prostate large enough to cause symptoms are rare. According to Springer out of 600 dissections he found two cases of cyst of the prostate. There are probably few mentioned in the literature because these cysts may be so small as not to cause interference and are thus overlooked.

In 1896 one case was found at autopsy in a man 23 years old. At that time there was no other case reported in the literature except those reported by English found in the newborn. Postmortem examinations by Springer during ten months together with the labora-

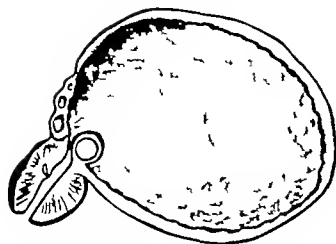


Fig. 1 Sagittal view after Abbe. Note ball valve character of obstruction.

tory cases of former years showed four cases three in adults and one in a boy nearly two years old.

It remained however for Abbe to report the first clinical case recorded in the literature in 1900. The symptoms of his patient corresponds exactly to the writer's case. The history of my patient is as follows:

MI R. age 42. Father and mother living and well. One brother died of phthisis pulmonalis. Five brothers living and well. No venereal history. Wassermann negative. Two years ago had a similar attack which lasted four days. Symptoms disappeared rapidly after the passage of sounds. On December 8 the patient consulted me and complained of symptoms of sudden onset which consisted of a frequent intense desire to urinate day and night. It was an unproductive urination. After he was apparently finished there would be a desire to urinate within ten minutes afterward. He had to strain at urination causing often the expulsion of gas and feces. His face would become suffused and the temporal arteries would become distended when the desire came to urinate. Finally after a few days there was absolute retention of urine. This necessitated catheterization twice a day for ten days. After this function was partially restored but the bladder never seemed empty and the straining efforts at urination continued. On several occasions we tried to retain a catheter in the bladder but the burning pain referred to the left side was so intense that it rendered this procedure impossible.

Cystoscopic examinations by Drs. B. A. Thomas and F. Block revealed an enlarged left lobe of the prostate. Otherwise the bladder appeared normal. On rectal examination the left lobe seemed larger and softer than the right.

On December 31 a suprapubic cystotomy was performed. Palpation of the prostate through the

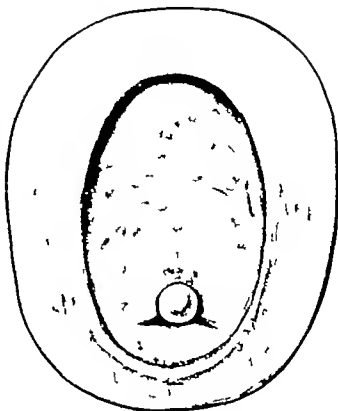


Fig. 2 Anteroposterior view after Abbe.

incised bladder revealed at once a swelling at the ventral surface of the prostate overhanging the urethra. It felt hard, solid and fibrous. It acted like a ball valve. The usual incision was made over it simply to evacuate and leave the prostate alone. However a cyst was entered the size of an ox heart cherry; its contents contained a cloudy fluid. The cyst was then thoroughly curetted with a sharp bone curette and the bladder was closed with an invaginating suture. A drain age tube was placed at the superior pole of the bladder. The tube remained a week and ten days afterward the patient passed urine in perfect comfort for the first time in several weeks.

The oddity of this case lies in the fact that the symptoms came on suddenly. One would expect that with the gradual filling up of the cyst the symptoms would come on gradually.

The similarity of symptoms between Abbe's and the writer's case prompts me to give in full the history of his patient.

A male aged 35 gave a history of an attack of acute retention of urine one year before which was relieved by subsequent catheterization. One pint of residual urine was obtained. No cause of the obstruction could be definitely ascertained; a stone and hypertrophied prostate having been excluded.



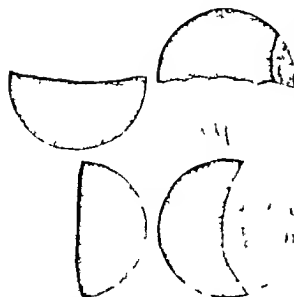


Fig. 3. Cystoscopic view. Upper left: tensor view; upper right: post. view; lower left: right; lower right: left view.

A plausible explanation was that of a persistent tumor of the bladder following the distention. The symptoms were not relieved by repeated catheterizations. A laparotomy was performed and a tumor the size of a hen's egg was discovered in the upper part of the internal meatus and the

upper portion of the prostate which acted like a ball valve obstructing the flow of urine. The cyst was transixed by a hook. The contents became smaller when the fluid drained off. The base of the cyst was sutured, the cyst having been cut away. The bladder was drained but drainage was not good in a few days. The patient remained free of symptoms.

Cases of hydatid cyst of the prostate with obstructive symptoms have been reported by Bangs, Jason, Wood, Winterberg and others, but the cases of Abbe and the writer seem to be the only ones of unilocular cyst of the prostate reported thus far.

Finally, I would say that obstructive symptoms in a young male without organic nerve lesion should not be treated too conservatively. A great deal of suffering can be avoided by an early exploratory cystotomy. My patient is now enjoying good health, urination is free and without any discomfort.

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# DEPARTMENT OF TECHNIQUE

## GREATER EXPOSURE IN THE KIDNEY APPROACH

By H J PRENTISS M D IOWA CITY IOWA

A TROUBLE in kidney approach is that sometimes the twelfth rib is placed very inferiorly or the kidney is located so high that it is very difficult to expose the viscus. If it is possible to rotate the twelfth rib upward considerable room is obtained. The twelfth rib is very firmly fixed notwithstanding it is called a floating rib. The reason of this is very evident. The diaphragm is attached to it and in contracting to increase the vertical diameter of the thorax the diaphragm naturally tends to swing the twelfth rib upward provided this rib is not anchored. This naturally is opposed to the physiological purpose which is to obtain the greatest space for proper lung expansion. How then has nature handled this problem? The middle layer of the lumbar fascia (the fascia between the sacrospinalis (erector spinae) and quadratus-lumborum extends to the

twelfth rib since the uppermost insertion of this muscle is in this rib and this middle layer of fascia is a part of the fascia covering of this muscle. Therefore this fascia becomes very much thickened between the transverse process of the first lumbar vertebra and the twelfth rib (lumbocostal ligament). This naturally resists upward displacement of the twelfth rib as the diaphragm contracts and is in fact a very strong ligament. If therefore we cut this ligament, the rib is freed and can be displaced so as to override the eleventh rib increasing the opening approximately an inch and one half.

The anatomy of this approach I have endeavored to illustrate. In Fig 1 on the right is seen the latissimus dorsi arising by its aponeurosis of origin from the spinous processes etc. This aponeurosis blends with the posterior layer of the sacrospinalis fascia. On the left



Fig. 1 (left) a Sacrospinalis enclosed in lumbar fascia b, internal oblique c quadratus lumborum in fascia d, latissimus dorsi e external oblique

Fig. 2 Sacrospinalis removed. On left, quadratus lumborum in fascia covering. On right, fascia removed except lumbocostal ligament. Sacrospinalis b lumbocostal ligament c quadratus lumborum uncovered d lumbar fascia enclosing quadratus lumborum e internal oblique



Fig. 3. (left) On right, quadratus lumborum detached and reflected, exposing twelfth and iliohypogastric and ilio-inguinal. On left quadratus lumborum pulled medially, anterior fascia incised exposing extraperitoneal fat. *a* Twelfth thoracic nerve, *b* iliohypogastric and ilio-inguinal, quadratus lumborum, *c* fascia incised exposing subperitoneal fat.

Fig. 4. Lumbo-costal ligament incised and twelfth rib rotated, *a* dotted line indicating the external arched ligament of the diaphragm but separated from the lumbo-costal ligament by the quadratus lumborum.

in Fig. 1 the *latus mus dorsi* has been removed exposing the sacrospinalis in its fascia and the lower limit of the quadratus-lumborum in its fascia, extending laterally to the sacrospinalis to attach to the crest of the ilium. This fact of the quadratus-lumborum extending laterally to the sacrospinalis near the iliac crest is of importance. An incision in this region brings us directly upon this muscle fascia which is thus readily opened. In Fig. 3 on the left the sacrospinalis has been removed, exposing the fascial compartment containing the quadratus lumborum and from which fascia arises the common aponeurosis of origin of the internal oblique and transversalis. On the right the fascia of the quadratus lumborum has been removed except at the level of the transverse process of the first lumbar vertebra where its thickening (the lumbo-costal ligament) extends between this process and the twelfth rib. This ligament is so dense that one has no difficulty in feeling it. Figure 3 shows on the right the quadratus lumborum reflected medially exposing the anterior layer of the lumbar fascia, which is a part of the sheath of the quadratus lumborum. Here we see the twelfth thoracic nerve and the common trunk of the iliohypogastric and ilio-inguinal coursing through this fascia, because of its thinness. The common aponeurosis of origin of the internal

oblique and transversalis which arises from the lumbar fascia surrounding the quadratus lumborum is so dense that these nerves are not seen as they pass through it to get between these two muscles.

This point is worth considering because it is necessary to open into the fascial compartment of the quadratus lumborum to liberate the lumbo-costal ligament and one can avoid these nerves in entering the abdominal cavity. On the left the quadratus lumborum is reflected medially exposing the anterior layer of the lumbar fascia which is incised exposing the fascia propria or extraperitoneal fat. Figure 4, on the right shows this lumbo-costal ligament cut through liberating the twelfth rib which is rotated upward, being limited in its range of rotation by the eleventh rib. On the left is shown a dotted line indicating the position of the external arched ligament of the diaphragm. Since we are behind the quadratus lumborum in this approach there is no danger of injuring the abdominal content or the nerves or the anchorage of the diaphragm. Figure 5 is a ventral view of the postabdominal wall. Here the left half of the diaphragm has been removed, the right half remaining. It shows the anchorage of the diaphragm via the crura interna, and external arched ligaments. On the left is dotted

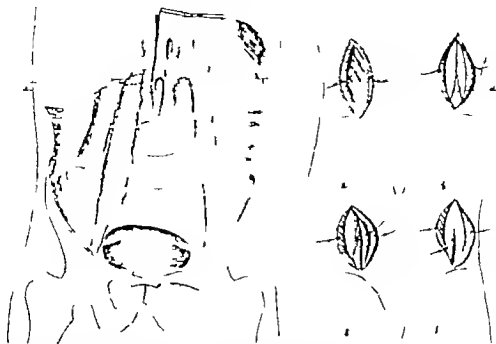


Fig. 5 (at left) Diaphragm removed on left. To compare origin of diaphragm with lumbocostal ligament. *a* Internal arched ligament *b* external arched ligament *c* transverse process of first lumbar vertebra behind psoas *d* lumbocostal ligament behind quadratus lumborum.

Fig. 6 Skin and fascia incised exposing latissimus dorsi *b* latissimus dorsi incised *c* sacrospinalis *d* quadratus lumborum enclosed in lumbar fascia *f* middle layer of lumbar fascia incised exposing quadratus lumborum *e* incision carried to upper limit.

the transverse process of the first lumbar vertebra which is behind the psoas and also the lumbocostal ligament which is behind the quadratus lumborum. This figure indicates the perfect freedom from injury in approaching from behind. Figure 6 on the left shows the incision through the skin and superficial fascia which is very thick in this region owing to its filling in the hollow of the back, due to the latissimus dorsi being adherent to the sacrospinalis fascia. The latissimus dorsi is exposed. On the right the latissimus dorsi has been incised and reflected

We come upon the lumbar fascia. Here we see the fascia of the quadratus lumborum extending laterally above the crest of the ilium to that of the sacrospinalis muscle.

In Figure 6 on the right (*f*) the fascia over the quadratus has been incised and reflected medially, exposing the quadratus lumborum muscle. We now may enter the compartment of this muscle and carry the incision freely upward to the rib on the left (*e*). The lumbocostal ligament is readily felt incised and our purpose accomplished.

## MODIFICATION OF THE UNIVERSAL INCISION IN EXPLORATORY LAPAROTOMY

B. D. DELFOR DEL VALLE, B. S. ARIAS, AND NITZE

THE progress which has been made during the last few years in connection with abdominal surgery is due to the roentgen ray and to exploratory laparotomy which have permitted us to prove the existence of pathological conditions in the digestive tract such as kinks, adhesions, Thompson membranes, ptosis and any modifications of the omentum.

The present day perfection in surgery (technique and instrument) has transformed laparotomy into an exceedingly simple and innocuous operation and at the same time permits of the total exploration of the abdomen. The coexistence of diverse diseases such as ulcers of the stomach or duodenum, appendicitis or cholecystitis makes it necessary in a great many cases to explore the various organs besides treating the principal complaint.

The Anglo-American school with an eminently practical spirit has adopted an incision which

in its situation and dimension is equally useful for any of these co-existent processes. I am referring to the incision generally known as the universal laparotomy incision which extends from the costal margin down to the umbilicus or lower if necessary parallel and one inch from the median line opening the sheath of the rectus muscle, retracting the muscle aside and penetrating into the abdomen through an incision of the posterior wall of the sheath. In Professor Decoud's clinics this method has been used for the last two years, with really good results. Although at first the incision might impress one as being rather exaggerated in length and its closure troublesome, with experience a surgeon realizes the enormous advantage to be derived from its use and inevitably adopts it.

Nevertheless it has several disadvantages, especially in those cases requiring total exploration of the abdomen or where the existence of adhesions makes necessary a considerable extension of the incision, even down to the level of the pubis. We have noticed three principal disadvantages: (1) The suture of the posterior portion of the rectus sheath becomes more and more difficult as the incision is lengthened owing to the lateral traction of the abdominal muscles. (2) There is always the danger of an evacuation through the cicatrix. (3) A great incision exposes the operator during the operative procedure to the emptying of the abdomen, especially in the cases of bad anesthesia, making it necessary to have an assistant. (3) Besides all this, there is added the fact that the many manipulation required in the above procedure increase the shock and this we should always try to avoid.

Convinced of the necessity of a systematic exploration in all abdominal operations and more so in chronic gastro-intestinal cases (chronic abdomen of the Americans) and taking into consideration all the disadvantages mentioned in the cases in which it is necessary to lengthen the incision, I have adopted a system which though slightly modifying the universal incision has all its advantages.

## TECHNIQUE

The technique which is employed is as follows: One inch parallel to the median line an incision is made on the right hand side of the abdomen



Fig. Author's incision. Pylorus & duodenum, stomach, & pericardic bridge. Douglas's pouch, cecum and appendix.

commencing two or three finger breadths below the costal margin and extending the same distance above the pubis. On the same line the sheath of the rectus is opened and the muscle retracted outward. In this way it is possible to make an incision on the posterior portion of the rectus sheath keeping the same distance from the median line. It is at this step that the modification of the incision occurs. The posterior wall of the rectus sheath is opened with two sub-incisions which leave between them an aponeurotic bridge of an inch or more in width. The inferior incision commences at Douglas arch and one or two inches above this arch the superior incision terminates.

In this manner it is possible to explore all the

abdomen and pelvis examine all the viscera and drain the pelvis avoiding the inconveniences mentioned above.

In the plate which accompanies this article we find in the middle of the incision the aponeurotic bridge (*d*) mentioned which is strengthened on its lower portion by Douglas arch (*e*). In the upper opening we notice that the hand is exploring the pylorus and the duodenum (*a b* and *c*). Through the lower opening we notice the caecum and the appendix held by a clamp (*f g*).

My experience convinces me that this technique is very satisfactory in extensive explorations of the abdomen for chronic or acute lesions.

## TREATMENT OF A DOUBLE FEMORAL ANEURISM BY PROXIMAL OCCLUSION WITH AN AUTOPLASTIC FASCIAL FLAP<sup>1</sup>

By EDWARD G. JONES, A.B. M.D. F.A.C.S. AND CHARLES E. WAITS, M.D. ATLANTA, GEORGIA

**A**NEURISMS of the upper femoral offer peculiar problems for at least three reasons:

(1) the many branches constitute a formidable handicap in any type of reconstructive operation. (2) obliteration of the vessel entails a material danger of gangrene. (3) when complete obliteration by ligature or otherwise is practiced and gangrene is escaped some degree of functional disturbance in the leg is probable. The gloomy truth of the last named fact is impressed on one by the exhaustive article of Dr. Halsted<sup>2</sup> on ligation of the common iliac which appeared in 1913.

This report however is not concerned with the wisdom or unwisdom of proximal ligation for femoral aneurisms but rather with the question how proximal ligation when necessary or wise may be done.

We take it to be an accepted fact that the ideal closure above an aneurism is that which *nearly* but not entirely occludes the lumen of the vessel.

If now one can almost occlude the vessel by some method which does not carry with it the danger of erosion and hemorrhage such as the metal band entails he will at least have added to the safety of the procedure. Dr. Halsted has met the objection to the metal band by offering instead strips of fascia lata (autoplastic or heteroplastic) and sections of aorta (heteroplastic) and

has been pleased with the results.<sup>3</sup> He is impressed with the belief that if the band does not permanently partly occlude the vessel the occlusion will last long enough to cure the aneurism. Dr. Matas at the late meeting of the Southern Medical Association in Atlanta stated that he has been experimenting recently with bands of rubber tissue for partial occlusion of certain vessels. The results of this addition to his already well known work of this sort will be awaited with interest. Where the occlusion may be accomplished by autoplastic tissue this would seem preferable to any other material. If furthermore the site of the proposed occlusion is such as to allow an adequate constricting band to remain attached at one end the possibility that the band will become permanently grafted upon the vessel or at least last longer than a similar detached piece of tissue will certainly be increased and the probability of cure of the aneurism correspondingly enhanced. The iliofemoral is favorably located in respect to the above conditions.

We present the following case as illustrative of what is possible in dealing with some aneurisms of this vessel and as suggestive of what occasionally may be accomplished elsewhere in the body.

W. C., colored laborer age 49 admitted to surgical service Grady Hospital September 27, 1914. Family history uncertain. Present history Some two moths

<sup>1</sup>Halsted, W. S. The effect of ligation of the common iliac artery on the circulation and function of the lower extremity. *Bull. Johns Hopkins Hospital*, Vol. xxiii, pt. 1.

<sup>2</sup>Halsted, W. S. *Ann. Surg.*, Phila., 1911, 5.

go noticed swelling in his right thigh short distance below the groin. There was soon little aching in the neighborhood of the swelling and a brown lower down the thigh. The patient frequently puts his hand on the swelling and feels throbbing.

He is well nourished of good muscular development. On admission temperature as 98° pulse 84. Temporal and distal vessels sclerosed. Postero-external of trochlear and inguinal lymphatics enlarged. Pupils equal react to light and accommodation. The poor condition. Odor of prostrata. Lungs normal to percussion and auscultation. Heart normal. No fifth rib space. The abdomen presents no peculiarities. Over the patient's back and to lower extremities elsewhere the skin shows eruptive characteristics of psoriasis.

Beginning 6 centimeters below Poupart's ligament on the right the course of the femoral artery is there rounded pulsating expansile enlargement. It has diameter of 5 centimeters. 1 centimeter below the lowest margin of the enlargement just mentioned, there is in the line of the artery an enlargement 3 centimeters in diameter exhibiting expansile pulsation. Compression of the artery above stops pulsation and lessens size of swelling. Treatment as Antiphilic treatment as kept for three weeks before operation.

October 3, 1904, curved incision 4 centimeters long, covered down and uncovered the beginning of the right femoral artery. Poupart's ligament, and the lower femoral oblique, psoas major, a little distance upward and external iliac glands are removed. A little distance upward a flap of psoas major membrane 1 centimeter wide and 5 centimeters long (large Poupart's ligament) immediately overlying the artery was dissected up, being left attached to its outer extremity. It is wound once around the artery and tied back in place. It is just enough tension to obliterate pulsation in the vessel and in the aneurysm below. A chromic gut is used. The superficial epigastric is tied and cut. Banding of the artery is carefully avoided. The overlying skin flap stitched back. The right leg is ordered kept straight in hot water bottles.

November 4, 1904. There is no discomfort in leg. Seems the same temperature as opposite leg. Aneurysmal sacs are small but exhibit no pulsation.

November 5, 1904. The aneurysmal sacs are about the same size immediately after operation, no pulsation.

November 9, 1904. The patient is up. There is no apparent disturbance of function in the leg. The aneurysmal sacs decidedly smaller no pulsation.

January 4, 1905. The patient returned to the hospital with small sacs and the operative wound. A knot of ligament as removed. The swelling representing the aneurysm can barely be palpated. The leg is in good condition. Antiphilic treatment has been continued.

June 9, 1905. There is no sign of aneurysm. There is some pulsation. Scarpa's triangle but the area is quite smooth. No trouble is experienced in using the leg but there is some numbness in the calf most of the time.

December 9, 1906. Function is good. The patient says there is some numbness and occasional aching in the calf of the leg but it occurs every day. There is normal pulsation. The groin point slightly below Poupart's ligament. Beginning 5 centimeters below this latter point diminished pulsation in femoral line can be felt and followed farther down the thigh but there is no evidence of either aneurysm.

The procedure outlined pulls the artery somewhat sharply forward out of its course. While we



Fig. Drawing showing partial occlusion of primitive femoral artery with band of fascia from Poupart's ligament.

did not think erosion and hemorrhage would occur we recognized it as a possibility.

We also needed to know whether the vessel could be kept closed or approximately closed for such a length of time as would reasonably guarantee the cure of an aneurysm.

We furthermore needed information as to whether such an approximate closure would frequently endanger the limb or seriously impair its function.

So far as the foregoing questions may be cleared up by using dogs for comparison we were able to get uniform satisfactory answers.

1. We have occluded the femoral immediately below Poupart's ligament by a band of fascia as above described 25 times in 15 dogs. The dogs have been kept alive from 2 to 18 weeks, and in no instance has there been hemorrhage. Further more nearly all of these vessels have been examined at varying periods after occlusion and it was evident that in no case was there danger of subsequent erosion.

2. Most of these vessels have been examined at periods varying from 4 to 16 weeks after being occluded to determine if the occlusion were still present. Without exception there has been a very much smaller artery below the constriction than in the other thigh used for comparison.

With great uniformity when the vessel has been uncovered above and below the constriction there has been the full pulsating external iliac apparent both stopping flush with the occlusion and below



Fig. 2

Fig. 3

Fig. 3

Fig. 4

Fig. 4

Fig. 5

Fig. 2. Showing occluded vessel before and after lumen had been opened.

Fig. 3. Also showing vessel before and after lumen had been opened. Complete occlusion.

Fig. 4. Apparent partial occlusion fourteen weeks after application of band.

Fig. 5. External appearance of occluding band fourteen weeks after application.

the band a cord which pulsed feebly or not at all until a point was reached corresponding to the giving off of the deep femoral.

3 It may be questioned very properly whether partial or total occlusion of the femoral in a dog jeopardizes the limb so much as a like procedure in man. Nevertheless we submit the information that in none of these 24 instances was there evidence of gangrene. We know that in a large percentage of these dogs the vessel was entirely occluded (see illustrations) whether immediately or gradually we do not know. Following the operation our notes show that the pulse could be palpated somewhere in the leg on an average on the tenth day. The earliest palpable pulse is recorded on the sixth day and the latest on the twenty fourth day.

All the dogs were kept alive long enough for observation on loss of function. The average dog was lame for 5 to 6 days but it is doubtful if this was anything more than soreness from the wound. A few were more or less lame for 2 to 3 weeks but none of these failed to recover apparent normal use of the leg. We are not entirely convinced whether or not the bands when applied so as still to allow the passage of a small current of blood will cause a permanent closure of the vessel. In the first place in experimenting with small dogs it is difficult for one to know with precision if he has or has not drawn the fascia to just the exact tension which will produce this result. In the second place a certain degree of relaxation probably always occurs. We know (see Fig. 3) that the band drawn snugly around

the vessel effects a permanent closure either gradually or immediately but we do not know beyond any doubt whatever that through error the band was not drawn too tight when applied.

During the earlier of these experiments we were more concerned with the problems of hemorrhage from erosion and whether the band would constrict the vessel long enough than with the question of whether a band so applied would permanently occlude the vessel. We believe that permanent closure follows the application of the partly occluding band but the number of our experiments and the attention we have given this feature do not at present justify the statement without qualification. We believe that in the vessels shown in the illustrations the closure was gradual. One photograph (Fig. 4) shows a vessel which was removed 14 weeks after application of the band. There seems to be a small lumen at and below the constriction but the microscope shows that intimal proliferation is filling up the vessel.

Histologic examination of sections cut through the point of constriction shows the vessel wall embraced by fibrous tissue, which seems to be the fibrous tissue of Poupert's ligament itself. There would seem to be no reason to assume that it is a substitution for the band rather than the band itself. Indeed, microscopically there is every evidence that the original tissue is in place. The band can practically always be traced outward from the vessel to blend with the aponeurosis; it cannot be identified and traced so uniformly to its inner attachment.



# A SIMPLE AND EFFICIENT METHOD OF SUPRAPUBIC BLADDER SYPHONAGE

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ALL surgeons doing bladder work have at times difficulty in obtaining perfect bladder drainage. This is essential in keeping the wound and dressing dry, and the patient comfortable, also in keeping the space of Retzius free from urine and thereby eliminating a serious source of sepsis.

For a time we have used the apparatus suggested by Dr. Bremmerman and found the interval syphonage of great advantage. The following much simpler method suggested by Dr. D. H. Arnott can be set up without any special apparatus and works perfectly doing away with the splash and giving a silent syphon.

Dr. Bremmerman's Apparatus. From John B. Murphy, vol. 5

3

A curved glass tube (1) is fixed by means of a small piece of rubber (B) or paraffin in a 6 or 8 ounce glass syringe (C) from which the plunger is removed. The end (D) should be cut on the bevel to allow the air to enter and break the column of water (a piece of rubber tube half an inch long with an inverted V cut in the side answers the same purpose). Water from the reservoir (E) is allowed to drop regulated by a screw clamp (F) into the syringe.

The flow can be regulated so that the syphon will run continuously or at any given interval. We have found that five and one half minutes keeps the dressing dry in the average case.

The V tube (G) is of course below the level of the patient's body (H) connects with the bladder drain.

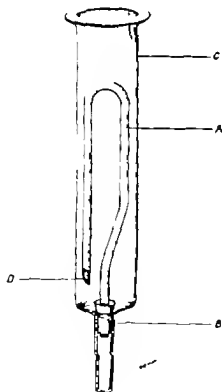


Fig. 1

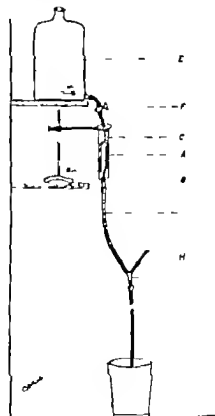


Fig. 2

By using a reservoir that will hold several gallons (a 2-gallon demijohn will answer the purpose) The apparatus will run for 12 hours or longer without refilling

The amount of urine passed by the patient can be determined by measuring the amount of water placed in the reservoir and deducting this from the amount of fluid found in the pail

## A SPLINT FOR THE TREATMENT AND TRANSPORTATION OF FRACTURES OF THE LOWER EXTREMITIES<sup>1</sup>

BY CHARLES T. BUTLER, M.D., NEW YORK

FROM June 10 1916 to January 10 1917 I had the opportunity while located at the Military Base Hospital at Ris-Orangis France of which Dr. Joseph A. Blake was chief surgeon of treating simple and compound fractures of the lower extremities with the Blake (a modified Thomas) and Hodgen splints in connection with the balanced suspension method developed by Blake. The splints used were solid

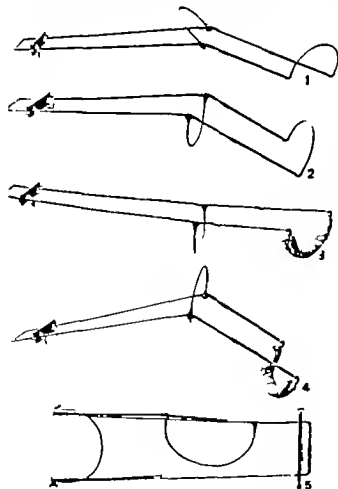
iron and it was necessary to have on hand left and right splints and different sizes of each as well as Hodgen's splints with varying angles at the knee.

On my return to this country I endeavored to incorporate the principles of these two splints in one apparatus and to introduce a joint at the knee. I endeavored too to produce at the same time a certain latitude of width at the knee and thigh and an adjustment of the thigh length.

The accompanying photographs will illustrate some of the various positions in which this splint may be used.

The position in Fig. 1 is that of a right Hodgen with spreader at the knee thrown forward.

In Fig. 2 the position of a left Hodgen has been obtained by shifting the relative position of the tubing: the near tube has been pulled away from, the far one pushed toward the center of the splint. Any desired position is rigidly maintained by a friction lock which is easily loosened by pushing the metal cuff with a spiral motion toward the center of the splint and tightened by the reverse motion. In this instance an additional width of one inch at the knee has been obtained by unscrewing the joint locks and placing the spreader inside instead of outside the joints. The spreader may be placed either above or below and in the latter position is much more convenient in cases where wounds of the anterior surface of the knee are present.



Figs. 1 to 5

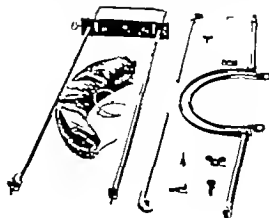


Fig. 6

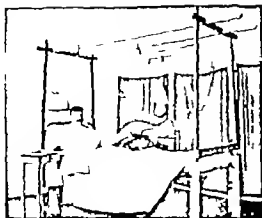


Fig. 5. Illustrating one type of balanced suspension frame. The patient's leg is suspended in a left Hodgson splint without tension. The trolley keeps the suspension rights perpendicular. The patient sits up or lies down. The cord passing through the pulley on the trolley is tied to a strip of flannel or adhesive applied to the sole of the foot and prevents foot drop. The container holds material distributing the heat of the Carrel-Dakin treatment as shown here.

It may be noted here that the thigh splint may be increased by drawing both tubes away from the knee joint and also that the thigh splint may be made wider narrower by altering the relative position of the sliding tubes. The width is greatest where the tubes are the same distance from the knee joint.

The use of the apparatus in a straight Blake splint (Fig. 3) is not necessary. If the tube section is run over and replaced on the rods. A left-right Blake splint is obtained in the same way as described above for Hodgson splint. A cushion of rubber cloth is laced on as in this position the semicircular rod rests all up against the tuberosity of the achium.

The spreader of the knee joint is not absolutely essential when the splint is used straight but gives additional support and is used if use in case of later date seems advisable to bend the knee (Fig. 4). In the bent position the spreader is essential to insure strength.

The extension bar of the foot slides readily along the splint and may be fixed in any desired position by means of the set screws. The sides of the buckles are attached to the extension band that has been fastened to the limb and knotted on and passed through the center hole runs over pulley at the foot of the bed and is attached to the tension weights.

Figure 5 illustrates the splint (7 by 35 inches).

Figure 6 shows the component parts of the apparatus.

Extension is maintained by means of mole skin strips applied to the limb below the site of fracture or cotton flannel strips held by Heussner's glue or by an ankle. The ends in each case being attached to the buckles of the extension bar. Finocchetto's stirrup or the Steinhilber pin may also be used with this apparatus.

The limb is supported in the splint either by single double faced muslin or cotton flannel bands (from four to five inches wide and from fourteen to eighteen inches long) or better yet by one-half of an ordinary 3 or 4 tailed Scultetus binder. The latter method insures a uniform and smooth surface for the leg to rest in. It is easily adjustable at any point, and prevents the skin from becoming ridged between adjacent bands as so often happens when the single ones are used. Double faced rubber cloth is most satisfactory in the region of the wound is quickly cleansed and may be used repeatedly.

Ordinary spring paper clips about two inches long are extremely useful as a means of fastening the supporting band to the splint. They never slip and are quickly and minutely adjusted and there is no danger of infecting the fingers from pinches as sometimes happens when safety pins are employed.

The splint is used to best advantage with the balanced suspension method described by Blake (1) (Fig. 1). The advantages of this method of treating fractures of the lower extremities have been conclusively demonstrated in certain war hospitals in France and the method is now being used to some extent in this country. The patient is infinitely more comfortable than when treated with plaster or Buck's extension. He can sit up in bed, lie down or move from side to side at will. Wound if present are easily dressed, and the technique of the Carrel-Dakin method of sterilizing infected wounds can be minutely carried out. Massage of toe ankle knee and hip joints and effleurage of skin and muscle can be done, and above all cleanliness can be constantly maintained. It has been found that wounds heal more rapidly, the consolidation of fractures is quicker and better and the tone and spirit of the patient is kept at a higher level.

The splint may be used for the transportation of fractures of the lower extremities in the manner described by Blake (2). In the Blake position, the semicircular rod with cushion laced on is placed well up against the tuberosity of the achium (as a fixed point) and prevented from slipping backward by a bandage across the front of the thigh. Extension bands attached to the limb or the straps of the ankle laced on over the shoe are fastened to the buckles of the extension bar and the latter is then extended to the required point, and held there by the set screws. The whole limb well padded is then bandaged in the splint. The splint, supporting and extending the fractured limb may then be suspended by a spring from the roof of an ambulance or hospital train car or

laid on a pillow. This method minimizes during transportation the danger of injury to muscles, nerves and blood vessels from sharp fragments of bone, aids drainage and considerably lessens pain. Decubitus over the tuberosity of the ischium is prevented by discontinuing the extension for a short time every forty-eight hours or so.

#### PRECAUTIONS

1. The splint should be kept on the same horizontal plane with the long bones.

2. When used as a Blake splint, the padded semicircular rod should be kept well up against the tuberosity of the ischium.

3. When used as a Hodggen's the joint of the splint should always be kept opposite the knee joint and the thigh length adjusted to meet requirements.

4. The flat side of the joint should always be placed upward and the tubing changed to meet the requirements of a Blake or Hodggen splint.

#### ADVANTAGES

1. It is adaptable for any fracture of either leg and as such may be used either as a left or right Hodggen or as a left or right Blake splint.

2. It can be used for transportation purposes.

3. Active and passive motion of the knee-joint may be begun early, thus decreasing the chance of adhesions which must be later slowly broken down.

4. It is collapsible and easily packed.

I wish to thank Dr. Hugh Auchincloss for his valuable assistance in the perfection of the first apparatus.

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## METHYLENE BLUE IN THE DIAGNOSIS OF ACUTE PERFORATING GASTRIC AND DUODENAL ULCERS

By HULLIER L. BAKER, M.D. CHICAGO

Resident Physician, Cook County Hospital

THE diagnosis of acute perforating gastric or duodenal ulcer in the absence of a good history is often extremely difficult. Indeed the diagnosis is frequently not made until the abdomen is opened. In reviewing the case histories of acute perforating ulcers occurring in the Cook County Hospital during the past six years one is impressed with the frequency with which the pre-operative diagnosis of acute appendicitis was made. It has even happened that on opening the abdomen the appendix has appeared markedly injected and covered with fibrin, and appendectomy has been performed and the peritoneal cavity closed only to discover at autopsy that the real pathology was located higher up in the abdomen at the site of a solitary perforating duodenal or gastric ulcer. With this in mind it occurred to the author that by introducing some non-toxic coloring matter into the stomach before operation, the diagnosis of perforation might be greatly facilitated and the site of the lesion readily determined with the minimal amount of handling and traumatism of

the viscera. The subsequent shock and the spreading of infection would also be greatly minimized.

The coloring matter chosen was medicinal methylene blue, a substance easily procured, readily soluble, and the color of which is easily detected and should not be mistaken for body fluids. The practical application of this method is well illustrated in the following case.

A P., a colored male of 19 years and a cook by occupation, was admitted to the Cook County Hospital March 21, 1917, on the service of Dr. Wolff. The examining room diagnosis was peritonitis. The patient stated that on March 21 at 9:00 a. m. he was seized with an attack of excruciating pain in the epigastrium. He vomited a greenish colored fluid. Severe and cramplike pains persisted in the epigastrium for several hours. Later the pain was referred to the lower right quadrant of the abdomen and has recently become generalized over the entire abdomen. No previous ulcer history could be elicited.

Physical examination revealed a young colored male apparently acutely ill. The abdomen presented a typical "board-like" rigidity and the bellies of the recti muscles stood out prominently. The rigidity is most marked on the right side. There are two definite tender points, one

In the epigastric region to the right of the umbilicus and the second or M Burney point N dullness in the flanks. Rectal examination negative. Heart, lungs and extremities negative. The patient's temperature was subnormal—95 degrees pulse 70 and respiration 24 per minute. The urine contained albumin and hyaline casts. The white blood count was 5,000.

A tentative diagnosis of appendicitis was made and the probability of a ruptured gastric ulcer was strongly considered. Two hours before operation the patient was given by mouth, 3 grains of medicinal methylene blue dissolved in one ounce of water. At peritonitis a right rectus incision was made over the appendix. The appendix was carefully examined and appeared quite normal. Accordingly the operative incision was prolonged upward. The peritoneum was acutely inflamed and discolored a bluish green hue. Traction was made on the greater curvature of the stomach, when a fine stream of bluish fluid was seen to spurt out through a small perforation on the anterior surface of the duodenum. The presence of the coloring matter in the stomach and its subsequent passage into the peritoneal cavity directed attention immediately to the site of perforation. The ulcer was repaired in the usual manner and the peritoneal cavity closed with drainage. Convalescence was uneventful until the sixth day when the pulse and respirations became accelerated the patient talked irritably and had to be retrained in bed. Death occurred the same evening.

The autopsy was performed shortly after death by Dr John W. Nuxum. There was no peritonitis present. The ulcer was neatly repaired. The duodenum and adjacent tissues

were covered with a thin layer of fibrinous exudate a bluish green color. Death was due to a hypostatic bronchopneumonia of the dependent portions of both lungs. The anatomic diagnosis follows:

Solitary perforating ulcer of the first portion of the duodenum recent surgical laparotomy incision surgical repair of the duodenal ulcer free clotted blood in the distal ileum, greenish discoloration of the mucous membrane lining of the stomach, fibrous adhesions between the anterior surface of the first portion of the duodenum and the inferior surface of the right lobe of the liver and between fundus of the gall-bladder and the hepatic flexure of the colon early hypostatic bronchopneumonia of the dependent portions of both lungs bilateral focal fibrous pleuritis fatty changes in the liver and kidneys cloudy swelling of myocardium acute emaciation.

After reviewing the literature I have been unable to find any reference to the use of bland coloring matter such as methylene blue as an aid in the diagnosis and localization of acute perforations of the stomach or bowel. The method is extremely simple, devoid of danger and appears to possess several features of practical value. Chief among these are the ease and rapidity with which the diagnosis and site of perforation can be determined and with minimal amount of shock attendant on the handling of the viscera. The coloring solution should be given about thirty minutes to an hour before operation. The presence of the small amount of methylene blue in the fluid stomach contents which escape into the free peritoneal cavity will not increase the incidence of peritonitis and the advantages should outweigh any objection. A subsequent report will be made after a more extended trial of the above method in acute perforations of the gastro-intestinal tract.





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MAJOR GENERAL WILLIAM C. GORGAS  
Surgeon General, United States Army

# CLINICAL CONGRESS OF SURGEONS OF NORTH AMERICA

EIGHTH ANNUAL SESSION HELD IN CHICAGO, OCTOBER 22-26, 1917

## SYMPOSIUM ON WAR SURGERY

### TELEGRAM FROM PRESIDENT WILSON

*My warm greetings and best wishes. It cheers us all to see thoughtful  
patriotic work done in such a spirit.*

WOODROW WILSON

### ADDRESS OF WELCOME

By MAJOR A. J. OCHSNER M. R. C. U. S. A.

Chairman, Committee on Arrangements.

IN behalf of the surgical teachers of all branches in Chicago I extend a hearty welcome to our visitors and to the members of the Clinical Congress of Surgeons of America.

For several years the leading spirits of this Congress and the officers of the American College of Surgeons have quietly exerted their efforts toward the formation of plans for the standardization of American hospitals which culminated in a splendid conference just concluded in which many of you have participated.

The men here assembled tonight are most active in the conduct of American hospitals and most deeply interested in obtaining a high degree of efficiency in these institutions. With your enthusiastic support and your active personal participation, it will soon be possible for practically all hospitals in this country to achieve a standard far above the maximum that could have been demanded only a few years ago.

We have no desire to place a few hospitals on pedestals and to brand a large number of struggling institutions as hopelessly inefficient, because such a plan would ultimately do far more harm than good. Neither do we desire to limit progress by a plan of standardization. Centuries ago China standardized her industries and professional activities including medicine and we all know what the results have been.

With reasonable planning and widespread personal attention and publicity it seems possible to stimulate practically all hospitals in this country to overcome what defects there may exist in their

organization so that soon each one will excel in efficiency the best hospitals of today.

During past sessions this Congress has unconsciously done the profession of this country another great service. It has given a group of the younger clinical teachers an opportunity to demonstrate their claim to recognition as honest, industrious, capable, and painstaking scientific workers in the field of surgery.

No group of men is quicker to recognize merit than the men who attend this Congress from year to year nor more ready to relegate to oblivion the professor who imposes year after year the fruits of his indolence and arrogance upon his unsuspecting undergraduate students. Clinical teachers are in need of standardization quite as much as hospitals and you can be depended upon to do this service.

Above all things, however, we will count upon you to take an active part personally in furthering the wonderful work that is being done by the Surgeon General of the United States Army and those who are earnestly assisting him as his aids. His wisdom and skill have been the means of saving more human lives in the past than it is possible for any one to conceive.

He has the splendid support of such distinguished men serving this country as the Surgeon General of the Navy and the Public Health Service and of all the men who have been at the front and who will speak to you tonight.

The most important present duty for every member of this Congress consists in determining



in what way he can be of the greatest possible assistance to our Surgeon General.

There is no doubt but what this country could have built the Panama Canal without the work of Surgeon General Gorgas supported by the medical profession of this country but we can be very certain that this would have been done at the expense of hundreds of thousands of lives and that at the present critical time this country would not be able to use its naval forces on both sides of this continent because a transfer around South America would be out of the question.

This country is certain to win the war in any case but your efficient support of our Surgeon General will mean a shorter war and the saving of lives of many thousands of the splendid young men who are now preparing for service.

The reason why your service will be so valuable is not only because of your enthusiasm and ability but because you stand for surgery that is not only

surgically clean, but ethically intellectually and morally clean. With this support our young men will go to the front in the best physical, intellectual, and moral condition. They will bear their hardships well, and those who are wounded will receive such prompt and efficient treatment that their ultimate misfortunes will be as slight as human skill and earnest effort can safeguard.

Our leaders and among them especially Surgeon General Gorgas and Dr. Franklin Martin, have shouldered the task of organizing thousands of medical men into an efficient working force which never before has been equalled in this country in the field of military surgery. The benefits to our country resulting from their efforts will exceed our wildest imagination, and it is the great privilege of the members of this Congress to assist them in this magnificent work.

I welcome all of you to a week of activity full of inspiration and practical productive patriotism.

## THE SURGERY OF THE WAR AND THE PART PLAYED THEREIN BY AMERICAN SURGEONS

By MAJ. F. B. LUND, M.R.C. USA.

THE day of the individual has past. The war has seen that it is not merely duty and the privilege of the medical profession of these United States enlisted now against the German menace to serve the Government. The profession has responded fully to the task, and enrolled now in the Medical Reserve Corps are about fourteen thousand physicians. We need twenty-two thousand and we shall get them without a medical draft. The patriotism of the profession can be counted on.

After two years of patient endurance of the arrogance, insolence and intrigue of Germany, our President and Congress decided that our country should be enrolled in the real league of enforcement and take its place with those allies who are united by the holy bond of this inexorable purpose. We are in the throes of tremendous preparation, material and moral. Our time is new and earnest endeavor are being organized with serious and undiminished effort. We have hardly begun to scratch the surface of the field, and of all the times in history this is the last in which we ought to congratulate ourselves on what we are going to do. Until Germany has been defeated and we have had in that defeat our part have no right to point with pride. Our only purpose should be now realizing the magnitude of our task to work the harder to make our belated efforts tell. In the homely phrase of our countrymen we must say nothing is too good for us. And yet we may be proud that the medical profession can help our Government had entered the war gave of the very flower of its ranks in the aid of the allies. Since the spring of 1915 the American Hospital at Neuilly has been

conducted first by the Cleveland Unit under Crile then by the Harvard Unit under Cushing and Greenough and, since the summer of 1915 by Hutchinson of Philadelphia. Nor should we forget Joseph Blake of New York who has given longer and more arduous service to the French than any other.

In the spring of 1915 the Northwestern University Unit in charge of Dr. Neff left service with the British at Etaples. The organizer of this unit was the late Dr. John B. Murphy of Chicago. John B. Murphy that most brilliant and sagacious surgeon, teacher unsurpassed, founder and supporter of this organization.

Since 1915 Harvard has officered a base hospital near Boulogne, under the leadership of E. H. Nichols, Faulknor, Cheever and Jones until February 1916 three months before we began hostilities, Hugh Cabot took charge of the remainder of the war.

At once upon our entrance into the war the Cleveland Unit left again, under the Stars and Stripes this time and was followed almost immediately by the second Harvard Unit organized by Cushing, the Northwestern of Chicago, by Bealey, the St. Louis by Murphy, the Johns Hopkins, by Finney, Columbia, New York by Brewer and the Massachusetts General by Lincoln D. via the Roosevelt by Peck. Nearly thirty other Red Cross units have been organized and are ready to leave at once when called.

Two members of the medical service have been the first of our combatant forces to have the honor of giving their lives for their country. Lieutenant Fitzsimmons of Kansas City, member of the Sec-

and Harvard Unit and Lieutenant Howe of Boston, who was killed in field service with the British Army. He was the first member of the American Army to be killed in battle surgeon intrepid explorer scholar officer and gentleman, he could not have asked a better death.

The Surgeon General's office is a seat of activity on a tremendous scale. Our President realizing the importance of the part the medical profession must play in this enormous task has appointed a medical member of the Council of National Defense — none other than the honored secretary and I may say, founder of this association and of the American College of Surgeons Dr. Franklin Martin. His vision, courage, and executive skill made possible these organizations and have found fitting recognition in the important part he is playing in the medical side of the war. As a member of the Council of National Defense and chairman of the General Medical Board, he has more than justified by his untiring and successful efforts, the high honor to which his merits have raised him.

The Surgeons General of the Army and Navy faced with the enormous and what to a military man must have seemed an impossible task of fitting civilian physicians into the expanded military machine have acted with a breadth of vision courtesy and fairness in an effort to put each man where he would do the most good which has excited the wondering admiration of all. If we of the rank and file but render our services in the same spirit our part in the war will be a proud one. When we hesitate to leave our practice and the places we have established in the community and for the brilliant results of civil work, exchange the tedious care of the shattered bones and dirt infected wounds of this war we must remember that the wounded men have sacrificed not only their professions but their lives their health, their all.

If discouraged by the nature of the work let us think of Carrel that wizard of technique who gave up his life of scientific achievement to take care of those poor bundles of mud and blood we call wounded soldiers and by the application of the same qualities to the new problem which he had brought to the old, has made a real contribution to surgery and humanity. At the very outbreak of the war he turned a keen untroubled face home to the instant need of things. He has set us a noble example. And so have Brewer Finney Crile, and others. Let us do our part.

The world can get on just now with the surgery of peace developed to the point which it had reached when the holocaust began, and to which American surgeons have done so much to bring it. If we do not do our war duty now the country at peace will be a poor place to live in and above all, we shall be compelled to live the rest of our lives knowing

that in the supreme need we shrank from duty. As the war has thrown civilization back to the earlier state of barbarism so surgery has been thrown back from the aseptic to the antiseptic period with all that that implies. We may not like it indeed, but it is not what we like but what meets the need, that we must do and so do with all the zeal and skill that we can bring to bear.

To the older of us the war has brought the priceless opportunity of doing before we die something really unselfish. The day of the young man in medicine has come, and what would we older men give to be starting in practice now, at this very moment of the world's history? Dark and doubtful as the future must sometimes look, clouded by the storms of shot and shell saddened by starvation, mutilation and the suffering of the innocent still here is our glorious opportunity. We have the privilege to help put an end to this horrible night mare that hovers over the bosom of the once fair earth. We must and we will.

For the lies the Hun has spoken,  
For the scrap of paper torn,  
For the ancient treaties broken,  
For the solemn oaths, foresworn

For little children, lying dead  
Beneath the ocean deep  
For the coward shot their souls that sped  
To their eternal sleep

For the sack of the Belgian cities  
By murder, rape and fire  
For the maidens' honor sacrificed  
To slake the Hun's desire

For our boys in the sunny fields of France  
Who were not afraid to die  
For the little wooden crosses  
That mark them where they lie

For the blood that flowed on the desert road  
By Tigris swollen flood,  
For the sweat and stench of the shell-torn trench  
In Flanders rain and mud,

For the men that have died on the mountain side,  
Where Italy's brave sons  
Hurled backward from their rocks and crags  
The onslaught of the Huns.

When mother England, sister France  
Are battling for the right,  
And the thin line weavers help us God!  
What can we do but fight!

And so for England and for France  
Let Yankee cannon roar  
Till God's blue sky be blackened  
By cannon smoke no more!

## NEW SURGICAL PROBLEMS DUE TO THE WAR

By JOHN G. CLARK, M.D.

President-Elect.

BECAUSE of the world's titanic upheaval in which almost all of the North and some of the South American countries are now participating, the entire trend of surgery upon this side of the Atlantic has been diverted from the consideration of everyday clinical problems to those urgently brought into the foreground by war. From professional attendants in civil life, thousands of physicians in the United States under the tutelage and guidance of our efficient army and naval medical services will take their march behind the Charnot of Mars. Because of this transfer of professional interests from those of civil life to the emergency of military duty, the plan of previous Congressional transactions has been changed and your executive committee has wisely set aside the programmes of three evenings for the consideration of military and naval subjects. In deference to this variation from customary procedure, the presidential address will find its place in the programme devoted to clinical topics on Wednesday evening and it becomes my pleasure this evening to sit as an addressee in this assemblage of distinguished speakers who are intensively devoting their work to military affairs. They stand as our leaders not in the ranks of the warriors but in the human science, which deals with salvage rather than with destruction. They are concentrating their efforts upon camp sanitation and medical prophylaxis, two phases of medicine which under the discolorities of this generation and through their application and adaptation to the immediate stress of war have contributed many health measures which are said to have saved already more lives by warding off disease than were destroyed by all of Napoleon's armies. Soldiers suffering frightful wounds are quickly healed and are returned in full efficiency to their duties. Life-saving methods have been devised already and others are being recast for the near future which may revolutionize the practice of civil surgery after this war is over. Medicine, therefore, will come out of this destructive era far richer than it entered it. The great Nation announced that the discoverer of a method of controlling suppurations would deserve a golden statue. If that brilliant Napoleonic surgeon could be reincarnated and could walk the wards of the military hospitals of France, he would see the most magical changes in the treatment of injuries.

This evening we are to hear from the distinguished Surgeons General of the Army, of the Navy and of the Public Health Service and from our honored surgical ambassadors from the offices of the Surgeon General of Great Britain and France. In reviewing the phases of the colossal task of welding into efficiency a wonderful surgical machine, the parts of which we gathered out of the crushing havoc of

the early days of this war, we stand in profound admiration, especially when we realize what astounding results the British and French surgeons have accomplished in so brief a period and in the face of such discouraging and almost insuperable obstacles. Through the profound wisdom of our great executive President Wilson, a Council of National Defense was created some time before the actual announcement of the existence of a state of war by our government and for the first time in our history medicine was given a ranking position in a distinguished national body. Men of rare skill and preparation for their duties were chosen from civil life to occupy the chairs about this council table. From more than 140,000 doctors of the United States our President had a wide range for selection.

His medical adviser, for within our nation there is a large number of brilliant physicians and surgeons, many of whom possess unique executive capacity. In the plunge of a great nation from a pacific state into the terrible vortex of modern warfare, organizers of rare ability are the first essential. Many names were considered and out of this number a man was chosen who had created a great American surgical journal, had conceived, promoted and fashioned this unique annual gathering of American continental surgeons for clinical advancement and finally, as a capstone, had founded the American College of Surgeons, which has for its object the standardization and elevation of the practice of surgery. To Dr. Franklin Martin, who has had the penetrating vision to see beyond his time, we are all deeply indebted for his contributions of epoch-making ideas and for the energy to put them into force.

It is with keen regret that I announce that Dr. Franklin Martin, because of illness is prevented from taking his place on our programme, but with his excellent executive foresight he has prepared a very happy surprise for you through his invitation, Mr. Daniels, the Secretary of the Navy, to honor us with his glad presence this evening.

Two phases of the Honorable Secretary's administration of his high office have a very vital bearing upon the health and moral welfare of our sailors. First, he abolished alcohol from our ships and naval reservations and second, established well-planned restrictive and educational measures for the purpose of shielding the young men of the Navy from the great venereal peril thus reducing two evils, which strike at the very foundation of health, efficiency, and manly character.

To Secretary Daniels, therefore, we, as a Clinical Congress of Surgeons, offer our cordial commendation of his most worthy attitude and pledge to him our allegiance in his great work.

## THE PHYSICIAN'S GREAT PROBLEM IN THE WAR

By Hon. JOSEPHUS DANIELS

Secretary of the Navy

AS I was leaving Washington a friend intimate enough to speak with frankness said that he could well understand how I could invite myself to come to Chicago and get an audience of 15 000 young sailors at the Great Lakes because under military service regulations they were compelled to attend and hear me but he could not imagine how I could obtain an invitation to speak before the most distinguished body of surgeons in the world Well I told him I thought he ought to know me well enough to know that knowledge of a subject was an embarrassment and that the only man who could speak well on a subject was the man who had no embarrassment of knowledge that really the reason I had been invited was because I had suffered many things of many physicians

Frankly I was ordered here by Dr. Martin and the Surgeon General of the Navy and if I always had such assignments I would be willing to have them assign me every day in the year

It is a great privilege to speak therefore as one who has always honored the profession in this presence. It was gratifying to hear both of your speakers refer as they have done to the distinguished services of my distinguished friends, Dr. Gorgas, Dr. Rupert Blue and the Surgeon General of the Navy my warm friend Dr. Braisted. I feel we ought to say to each one of them what the great city surgeon said to William McClure: You are an honor to your profession.

Charles Reed never gave us anything so interesting and so helpful as his picture of the physician in Put Yourself in His Place and I love to think of what the young man said to Dr. Ambeyne.

Talking to you is like drinking sunshine for you have that in your power not only by healing and the knife to carry into homes sunshine and cheer and health and strength and life you have that in times of peace. In times of war it is to the physician that the nation turns with supreme confidence in the belief that in preventive measures we may save the lives of the youths who are hurrying to the standards.

So much has been done in preventive medicine that no longer in the Army and Navy do we fear that scourge of typhoid fever. It is almost negligible and the skill of the men of this profession is lessening the danger of other diseases.

And with the advent of battle and the certainty that our country will have to pay its toll there is no finer spectacle of unselfish service worthy of the disciples of the Great Physician than hundreds and thousands of doctors and surgeons in our country who have enlisted who have volunteered in the Army and Navy going over to France ready to prevent disease by sanitation and wise

counsel and medical skill and to bind up the wounds and repair men who have been shattered and to make them again useful members of society.

Tonight speaking for myself and the Secretary of War and for our great leader President Wilson I wish to express the thanks of America to you gentlemen who are making these great sacrifices.

I know of physicians and surgeons giving up practices that are most valuable tearing themselves away from associations most tender donning uniform and giving themselves to a service that is essential to this great war upon which we have entered. They have no illusions about war. They know its toll.

Before America declared its participation in this worldwide war and gave notice to the world that the doctrines of force and divine right and ruthlessness should forever end these physicians were already succoring those who needed their help. And since they have come to us ready not to be trained we do not have to put them in training camps. They come as did the officers and men of the torpedo boat destroyers which we sent to England. You will recall the thrill that went over the world when the first installment of destroyers unannounced and unheralded reached port over there—I am not permitted to say where because of the rules and regulations. But when the destroyers came into port and were met by the British Admiral he said to the ranking officer: When will you be ready for service? And this young naval officer animated by the same spirit which animated John Paul Jones and Decatur and Dewey, said: We are ready now.

So these surgeons and physicians going into the national service have no waiting time. They come and say: We are ready now. And in our camps and cantonments which are being prepared they have given their counsel and advice so that the best sanitation may be adopted and hospitals may be erected.

This morning or rather last night at the Great Lakes Training Station here virtually in your own city—the largest naval training station in the world and the best, in company with the Surgeon General of the Navy I visited the units the new temporary hospitals there where we have installed the latest and most approved system to care for our men who are ill and I paused as we passed through the wards to speak to the lads who were in those hospitals and to talk with them and without exception they were cheerful. Every one of them said he felt better and was thankful that a grateful country would see to it that if they were ill or wounded not a thought of money would be considered in caring for them.

I wish to speak to you tonight and call you to a

high service which no other men in America can render. Too long we have had a conspiracy of silence about the most fostering evil that touches American youth. The day has come the hour has struck, when the prudery which has made us shut our eyes to the destruction of youth should demand that we shall quit lying and tell the truth.

We have now over a million men under arms and we shall soon have ten millions. If need be, I win this war we will call to arms every man under fifty and if it should chance that they may not win the victory then we will rob the cradle and the grave because liberty and equality and government by the governed shall not perish from the earth.

We are appealing to the manufacturers to turn out cannon and guns and ships and torpedoes and they are responding. We are appealing to skilled mechanics throughout America to do their level best to provide the implements of warfare and I want to say here tonight that the response of skilled mechanics in America has heartened and cheered every man in official life in Washington and every good citizen in America.

The whole of America is mobilized. The few who months ago seemed not to be thoroughly American have either been sent to jail or will have been sent there. But I am thankful to say and you should know that in America the number as numbers go is almost negligible and though the strong arm of the Government is raised, and though the various departments have a secret service that permeates every nook and corner of America, you can count by the hundreds those who have been caught red-handed in treason. And America is united more so on this proposition to win this war at the cost of the last man and the last dollar than it ever was on any proposition in the history of our country.

But we cannot win this war without soldiers and sailors with steady nerves and clear heads and men do not have steady nerves and clear heads unless they live straight lives. If anything on earth should cause me to doubt the goodness of God, it would be that he had given to mere boys the passions of manhood without the restraint of manhood.

Ten million men are going out to fight the battle of righteousness. And how are they clothed and what environment do we place them in. We talk about battleships. They are mere junk unless we have trained men and skilled men to man them. You put ten million men under arms and let a portion of those men be diseased and make no check on the immoral surroundings that we place them in, and the nation is unjust and unfair to those men and to itself.

For the first time in the history of the world our country has started in a new line. We have recognized the evil. We have no longer whispered about it in back rooms and have put poultices on the evil and tried to hide it while it lifted its head, but we have said. Let the sunlight come upon the diseases of immorality and let us appeal to young men to be clean in body as well as in soul.

The peril today is not merely the German gun. Lloyd-George said that England had two enemies the Germans and drink, and drink was the most dangerous of the two.

I tell you tonight there are a million fathers and mothers in America who are willing to make the sacrifice to send their boys to the front and jeopardize their lives, who are more afraid that their bodies will be tainted and that they will come back diseased through immorality than from German bullets.

It is a terrible menace. The diseases from immoral life are more deadly than tuberculosis, more deadly than cancer, than yellow fever and Dr. Osler says of all diseases that destroy manhood, that destroy homes that bring children into the world weak and puny and diseased, is the disease that comes from young men who are not moral and straight in their lives. That is the menace.

There comes news from Vienna, from General Hecht that three divisions of Austrian soldiers are out of fighting because of venereal disease. Seventy-eight thousand men in the English Army are impotent and put out of battle because of immoral disease. A little handful of Germans in Belgium have furnished 35,000 cases. What shall we do members of the profession, with these young men sent to the front?

The Congress of the United States has passed a law and put it in the hands of officials, to carry forward measures more drastic than ever dreamed of before. It is not only broad that this pestilence walks by day and destroys by night. It is in our own Navy it is in our own Army it is in our own civilian life. Think of it! During the last fiscal year because of the diseases caused by sin, 147,000 days were lost in the service of the Navy 460 men were incapacitated and if you add to them the number of men who have to nurse them and care for them, a whole battleship crew was taken out of the Navy because of this disease. One person in every two in the Navy had to be treated and almost as many in the Army.

Let us quit trying to use a poultice when we need the surgeon's knife. Let us recognize that this evil not only menaces the Army and Navy thus menacing national defense but it menaces every home and I came here tonight Mr. President and Gentlemen to appeal to the only men in America who can educate the people and compel a hearing. It is up to you gentlemen of the medical profession whether this evil is so presented to you men, is so emphasized, that it shall be lessened.

When a minister of the Gospel preaches against this, the young men think it is professional in the minister to tell them to be good and to keep clean lives. But when the physician, who brings us into the world and who closes our eyes in death and who takes care of our bodies when he speaks men hear him who turn a deaf ear to every other admonition. Therefore speaking for efficiency in the Army and in the Navy for I have no right to speak for the



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ADMIRAL WILLIAM C. BRAISTED  
Surgeon General United States Navy



civilian population any more than you have, I appeal to the physicians here and throughout America so to educate the youth of this country that we may stamp out this menace, that we may have a youth, clean in body clean in mind and clean in thought.

I speak to you with the seriousness and solemnity of one who has seen its ills in the service and out of the service and because I am profoundly convinced if the medical profession of America would stamp

out the lie that it is an unpreventable and necessary evil and convince young men that continence is the only safety we would eradicate this evil and make our young men all that their fathers and mothers wish them to be. Today as never before, American manhood must be clean. We must have fitness. America stands in need of every ounce of strength.

Gentlemen of the profession we must cut out the cancer if we would live!

## THE SURGEONS RESPONSE TO THE NATION'S CALL

BY SURGEON GENERAL WILLIAM C. GORGAS U.S.A.

A CONSIDERABLE proportion of the audience that I address are members of the Army Medical Corps and I will speak therefore to them principally as Surgeon General.

One of the speakers this evening has been kind enough to refer to certain incidents of the past life of the Surgeon General in a very complimentary way. I was however disappointed that he did not call attention to what seems to me a considerable job in my present life. There is not a man in the community who is not sure that he is just as good as anybody else in the community, and perhaps a great deal better than the doctor.

Now I have been accustomed to manage as Surgeon General of the Army a small number of doctors. We had gotten along pretty well because they had been used to this style of management for a number of years. I looked forward with considerable dread to the great addition which has occurred to the Army Medical Corps on account of the war and knowing this quality of the Doctor so well I expected to have considerable trouble in the management. But so far no great difficulty has occurred.

Now, I think this fact that the present Surgeon General has managed to get along for six months with 14,000 doctors without any great trouble, ought to be mentioned in the eulogies which have just been called to the attention of this office with regard to the present Surgeon General. I hope the next time I come to Chicago that this error may be corrected.

Our nation is in the most important war in which

it has ever been engaged and probably in which it ever will be engaged and we are fighting for the greatest principle for which we ever fought that is the freedom of the world. It seems to me, as we look back six months that we must acknowledge that the nation has responded most nobly in all its branches in every way.

I do not think anybody six months ago could have looked forward and expected the whole nation would have roused itself as it has and that we would as a nation have accomplished as much as we have at the present time. But I think, without belittling any other section of the nation, that our profession can claim pre-eminence. There is no part of the nation that has responded to such a degree to such a great extent, as the profession of medicine. It has been found that no other part of the nation has responded more promptly and in such a proportion of its number as the medical profession has been called upon to do, but at the same time I think it perfectly fair and just for us to point out to our fellow country men that we have measured up to all the requirements so far that have come to the profession.

There is no member of the profession in the United States that has assisted the office of the Surgeon General as much as these great societies one of which I am now addressing.

I wish, therefore as Surgeon General of the Army and as the representative in that capacity of our administration, to thank this association for the help which they have given us and I hope to thank them again for more help.



## THE NATIONAL BOARD OF MEDICAL EXAMINERS

BY SURGEON GENERAL WILLIAM C. BRAISTED, U.S.A.

THIS would seem to be a fit occasion to refer to the activities of the National Board of Medical Examiners. I wish I have the honor to be the presiding officer.

When the board was originally planned its purpose aimed at offering an examination which would be a test of qualified applicants, through which a group of experienced teachers in the federal services and in civil institutions might determine the knowledge of candidates by rigid test through which they might be certified as acceptable for the Corps of the Army and the Navy and for license in the United States and its extraterritorial possessions. The character of the examinations written, oral and practical in laboratory methods has already been extensively reported and discussed. The quality of the examination has been recognized through the acceptance of the written papers of those successful candidates who have applied for the federal services and further by the announcement that the Mayo Foundation in the University of Minnesota would receive such candidates if the National Board as follows without further requirements. The board has pursued this object with steady intent and has held three examinations with a total of 50 applicants of whom 30 have successfully passed.

After the conclusion of its June examination, the members of the board seriously deliberated the advisability of suspending all examinations during the period of the war. There seemed however to be a plain duty of service for the board to perform. As its creation contemplated as one of its main objects, the preparation of men for the Army, the Navy, and, in time for the Public Health Service, and as each of these national departments is needed men in their regular corps, the board concluded not only to go on with its examinations but to conduct them more often and to arrange to get the larger cities to bring the examinations to the interiors in the greater hospitals. An examination has just been concluded at Chicago with 9 addressees. In January an examination will be held in New York.

Not only does the examination of this board aid largely in the development of material for the federal services, but it additionally provides for the future adjustment of the men who are candidates for these services. Not only may we say how long the war will last, Young men going into the services of the Army and the Navy in the Reserve Corps, either at the end of the war returned from military duty, have to decide upon a location for their civil practice. Already a number of cities have indicated their intention of accepting the licentiates if this board upon registration and without further requirement. Other cities have legislation pending

to satisfy the legal requirements covering a like privilege.

The fact that 6 of the 15 members of the board are in the regular service of the Army, the Navy and the Public Health Service and others are in the Medical Reserve Corps makes it desirable that the work of the board in relation to the present war conditions should be accentuated. It may serve wider purpose if authorized.

There are several thousand medical men in the training camps and more will come. At the conclusion of the present hospital year or by July of 1918 many internes of hospitals now in the Medical Enlisted Reserve, will be assigned to active duty. The task of examining these young men in camp and those on the way will be delegated to some boards already active in the work for the Medical Reserve Corps. There will be many who would likely desire to go into the regular corps and who have the qualifications required by this board for its examination. By an early provision for the examination of the internes who are already on active military duty this board might arrange to examine all qualified internes before they go on active duty. Through the direction and with the co-operation of the Medical Departments of the Army, internes might be ordered to report for such examinations and, in this manner, the Medical Departments of the Army and the Navy could be relieved of a number of stated examinations and could conserve the time of regular examiners needed in their duty particularly as both of these services are already well represented on the Board. As a matter of fact with so large a number of the board either in the regular Corps or in the Medical Reserve Corps this board may be construed as being a quasi medical Board for the services only needing the authority to proceed.

The board has a particular value to the services, as well as to medical education, in that from the beginning it has stressed the importance of laboratory tests in bacteriology and in clinical medicine besides the practical clinical examinations in surgery and in medicine. If its operation is assured by the support of medical school faculties and by the profession at large, it may through the advice of those in authority increase its usefulness as time goes on. With the standardization of medical education, of public health methods of hospitals and their correlated activities, there must be some standard for testing the qualifications of those men who are coming to take charge of the problems which the future will bring.

By undertaking examinations at different great centers this board co-operating with the faculties of the leading medical schools will ultimately

extend its operation until it may reach a standard and that the standard at which it aims.

The test of the graduates of the best schools and the best hospitals will perhaps afford some criterion and the work of the board may point the way to a co-ordination of the Federal Services into a combined educational unit. Already the suggestion has come that the opportunity be afforded for young men to train for a medical military career. This

Board, which has successfully united the three federal medical services in a harmonious body working for altruistic standards for these services and for medical education generally may point the way to a *United Service Medical School*—a medical West Point or Annapolis—at which men may qualify for medical military service, after a training which will fit them under exceptional conditions for such a career.

## NATION-WIDE MOVEMENT TO PREVENT DISEASE

BY SURGEON GENERAL RUPERT BLUE, U.S.P.H.S.

THIS is the time for the estimation of values. Individually and collectively we are making many sacrifices. Every energy of the American people is concentrated upon the winning of the war. We feel that everything that leads to efficiency brings us nearer victory. Therefore with thankfulness I announce to you that the health of the United States is in better condition today than ever before. There has been an awakening of the consciousness of our American people. In the areas around the cantonments the state and municipal governments have joined hands in the prevention of disease. The water and food supplies the medical inspection of schools, the control of communicable diseases all have been placed upon a good basis. More than 75,000 Americans have voluntarily taken the typhoid inoculation. The extensive mosquito breeding areas have been practically rendered free from malaria. Thousands of rural homes have been provided with sanitary conveniences. The cantonment zones are gradually being extended just as a stone thrown into a pool throws a wave

to the furthest shore, so it is hoped that this work intensified by the stern realities of the war will finally spread to the farther corners of the country. Disease is being turned back from our shores by the emigration officials. Research is tracking infection to its lair and providing new methods for its control. There is a nation-wide movement for the prevention of disease. This is not accomplished by any one set of persons but by the American people. Health agencies could not have accomplished it no authority or propaganda could have attained this end. We are an intensely practical people and have to be shown before we will believe. In the days of peace it was almost impossible to convince the average American of the necessity of national hygiene but when we were forced into war when it became immediately obvious to all of us that we must fight there came the knowledge that these sanitary measures must be followed and out of this war will come a better stronger and more enduring national health.

## CO-OPERATION OF BRITISH AND AMERICAN MEDICAL CORPS

BY COLONEL T. H. GOODWIN

Representative of the Director General, British Army Medical Service

I WISH very much that I could adequately express to you my appreciation of the honor which has been accorded me this evening in the invitation to be here as a guest of this Congress. I only ask you to believe that I appreciate it very fully and very keenly.

The medical profession of this country and of Great Britain has for many years past been closely united in ties of social and professional friendship. The services of the armies and navies of both these countries have for very many years whenever they have met and in whatever part of the globe they have served together they have met in a spirit of the closest amity and comradeship.

During many years experience and service abroad I have come across innumerable instances of this

I remember several years ago when at a foreign station one afternoon I met one of our naval officers and he said to me "An American warship has just come in and I am afraid we shall have trouble tonight. I was, of course, very much surprised and indeed astonished at this and I am afraid rather horrified and he gave as his reason

You see whenever the American sailors and ours meet they immediately join together and proceed to tear up the town. And he added "And they do it most effectually."

It has always seemed to me and recently even more so that if they can do effectual teamwork in play they will do even more effectual teamwork in war.

The services of the two nations are now fighting side by side with a common object with identical

Ideals and with the certain expectation of mutually attained victory in the future although probably not in the near future.

Gentlemen I have been in your country for some five or six months. In no other country in the world could I possibly have received such a cordial welcome or so much general hospitality and such unvarying kindness as I have received here. My stay in your country will always be one of the happiest recollections of my life. This is due in general to the unlimited kindness which I have received from every member of our profession and in particular to the very fortunate fact for me that a great portion of my duty and my time has been spent in the office of Surgeon General Gorgas.

To the Surgeon General and his staff many members of whom have joined the service within the last few months I owe an unending and unlimited debt of gratitude. This debt does not rest upon my shoulders alone. The whole of the medical service of my army shares it with me and not only they but the whole British Army and the whole British nation owes a debt of gratitude to the medical profession of the United States which will never be forgotten.

When I came across here some few months ago we in Great Britain were in sore straits owing to our scarcity of medical men and nurses. We appealed to you in this country to help us. The response to that appeal was generous and prompt be-

yond any expression. Since that time nearly 600 medical officers and nearly 600 nurses have gone across the water to help Great Britain on the Western Front. The work which has been done and which is being done and which will be done by them is magnificent. Not a mail passes in which I do not receive letters from many of my brother officers from the highest ranks in both France and England, praising and expressing in terms of the highest eulogy and the most sincere gratitude the incalculable service which has been rendered by these officers and nurses.

Personally I very fully realize the amount of suffering, pain, and misery which has been alleviated by your brother medical men. I fully realize it and we all fully realize it and we are all grateful to you and thank you most heartily for it.

The friendship which has been felt for many years by the medical department of the armies and navies of the two nations will, I am confident in the very near future be equally felt by the peoples of those two nations. Surely a year or less of adversity, of devotion to a common cause, the cause of humanity of self sacrifice and suffering will weld this friendship to an extent which never could have been obtained by centuries of prosperity.

Gentlemen I wish I could express to you the gratitude which all my brother officers in the Royal Army Medical Corps feel to the medical profession of the United States. I am no orator and I can only tell you that I thank you from my heart.

## FRANCE AND THE GREAT WAR

By C. LOWELL C. DERCLE

Representative of the Medical Department, French Army

I DEEPLY appreciate the warm reception which I have received this evening. The manifestations of your sympathy move me more since I know they are meant less for me than for France herself. France whose boundless courage and indomitable valor you are applauding every day. In her name I thank you from the bottom of my heart. It is needless to say what France has done. Unprepared, shattered from the blow of Germany which had prepared forty years for war but after her surprise France gathered all her forces and energy and then, stronger than ever before she intimated to the Kaiser troops no prod and ure of living in Paris. France intimated to them to stop and they stopped. Let us remember always the battle of the Marne where the glory of the French Army under the command of its chief, Marshal Joffre accomplished such wonderful things. I cannot describe the great devotion which we witnessed. Everyone hears the voice of duty and thinks of

nothing else. Many have shown on the battlefield, their devotion by giving their lives, and I wish to salute them with emotion and pay them a warm tribute. But their deaths have never caused the discouragement to those who were to follow. On the contrary there have always been many to occupy the vacant places.

The American people has now come to help out as did the British people. We have now the British fury as we shall have in a short time the American fury. Your American Army will be served by a medical personnel of choice which will have at its disposal a man above all. I highly approve of everything I have seen in the training camps. I have visited and I can see that everyone, physician and surgeon, will be absolutely prepared to do his war work when the hour strikes. That is naturally due to the personal enthusiasm and activity of Surgeon General Gorgas who encourages everyone who works in his service. I wish him great success.

## ENGLAND AND THE GREAT WAR

By SIR BERKELEY MOYNIHAN C.B., LEEDS, ENGLAND<sup>1</sup>  
Colonel, British Army Medical Service

**A** MOST ample apology has been made already for me by Mr. Secretary Daniels for he says that there can be hardly any more crippling embarrassment than that which comes from a certain amount of knowledge.

At midnight on August 4, 1914 England to her lasting honor declared war against Germany. At 8 a.m. on August 5, 1914, I became a soldier of my Sovereign. From that time until I stepped on board the boat at Liverpool I have practiced military surgery. I have thought of military problems, and I have lived with military people. You will, therefore, expect from me some brief statement of the conditions under which we have worked something of the failures we have made and some thing of the successes we have achieved in the work of the Royal Army Medical Corps of Great Britain.

There are about 30,000 medical men in the United Kingdom of Great Britain and Ireland, and of that number about 10,000 have been and are now wearing the King's uniform as officers in his Army. One-third, that is to say speaking in round numbers of the medical men in our Kingdom have entered the military service and have seen active service or have seen foreign service.

The Government has the right and would, no doubt be prepared to exercise the power of taking every medical man of military age and compelling him to serve, but compulsion with us has been and always will be quite unnecessary.

If when the country is in danger the medical profession does not respond to the call who may I ask, is likely to do so? The medical profession in every country is probably that which has undergone a more complete education and has had better and closer opportunities for broadening the mind of each individual practitioner by contact with the most serious problems of life than any other profession. If, therefore, the intellectual aristocracy of a land does not rally to the flag you cannot expect anybody else to do so.

We are as a profession by intellectual descent, and by solemn adoption the heirs of the men who have made our race great and famous.

May I tell you in brief what has happened with regard to the work of the Royal Army Medical Corps in my own center of Leeds. We have there as some of you know a civilian hospital of about 480 or 500 beds with a staff of 4 surgeons and 4 assistant surgeons. When, with the far-sighted vigilance of Sir Alfred Krogh a territorial system of hospitals was established throughout the country Leeds was selected as one of the centers and we were asked if we could provide accommodation for and supply with an adequate medical and surgical staff a military hospital of 520 beds. We

agreed to do so and the men attached to the hospital staff became by that act officers in the territorial branch of the army. Of the 8 surgeons serving on the staff of the hospital, there are now 4 left at home and in the 4 I include myself who am sometimes in France often in London and occasionally in Leeds. With that depleted remaining staff with the help of the practitioners in the neighborhood we have now started and are running with an efficiency that I should not be ashamed to display to the most critical gaze of American surgeons a group of military hospitals of 6,300 beds.

The record of the Royal Army Medical Corps may be looked upon from two points of view we are both soldiers and doctors. As soldiers we go into any part of the line from the trenches to the base according to the needs of the moment.

Major Crile yesterday paid an eloquent tribute, which touched me very deeply to those boys of ours who as regimental medical officers are responsible for the health of the battalions which are actually in the fighting line.

Since the war began, until the 25th of August, which was the last date of which I could get information when I left England we had suffered, roughly in the Royal Army Medical Corps 1500 casualties that is to say that number of men had been either killed or wounded or gassed or disabled from further service in the Army.

As you may know the highest distinction which any Englishman can gain in the opinion of every Englishman, is the Victoria Cross. We have gained more than our share of that most coveted distinction. Twice in the history of that order a clasp has been gained which means that the officer wearing the distinction has won his decoration twice. Both the men who have won that decoration twice are members of the Royal Army Medical Corps.

Though we are soldiers we continue to be medical men, and I should like to tell you very briefly some of the achievements of the Corps regarded from a scientific point of view.

The history of medicine in the tropics is the history of the military medical services of America and of Great Britain. The hands of all men build the Temple of Science but now and again, once perhaps twice in a generation we have the high privilege of having among our number one of the great architects of the Temple of Science. You are perhaps just as full of joy as I am, to think at this moment and on this platform are two of the men, both of them Americans who have designed some of the magnificent additions which are being made to that glorious Temple of Science in Medicine and in Surgery. I need not tell you that I refer to General Gorgas and to Major Mayo.

To illustrate among the things which the Royal Army Medical Corps have done in preventive medicine no man could because it is easiest to convey the matter to a large audience figures referring to typhoid fever. Ninety-eight per cent of the soldiers going to fight in Flanders and in France in the British Army have been voluntarily inoculated against typhoid fever and this is the result. In the South African War which lasted as you know close on to three years we had 57,684 cases of typhoid fever with 802 deaths. In this war with an army ten times as large on a soil much more likely to bear carriers of typhoid and breed the flies by which typhoid is partly carried we have had in all up to the 31st August of this year 6,022 cases of typhoid fever with 9 deaths. That is to say we have had a far less number of cases of typhoid fever in this enormously larger Army living under infinitely more difficult circumstances than we had of deaths in the South African War.

In many other directions we have as a corps helped to stamp out or reduce the virulence of the many other diseases.

As you know in Africa one of the greatest pestilences which ages from the north to the south is known as bilharzia. One-third of the population of northeastern Africa suffers from this disease. When established it is absolutely incurable. The British Army is still paying penalties of something like seven thousand pounds a year to the men who contracted bilharzia in the South African War.

At the beginning of this war when it was realised that we would need to have an army in Egypt and a detachment of medical men was sent out to study this disease with the result that the alternative host of the parasite has been recognised in all his varieties, his modes of life have been probed to the bottom, all his domestic secrets are revealed, and rapidly he is being exterminated. If all human probability bilharzia which has existed from the days of the Pharaohs down to the beginning of the war will be stamped out from the face of the earth.

In many other directions, which I will not trouble you to cite to you we have made very pronounced progress in respect to our investigation of all spirochaetosis, trench fever, dysentery, malaria, cerebrospinal fever and many other parasitic diseases. I leave out of account for the moment any description of the surgical advancement because that will be discussed later, in other evenings in the week.

The profession, immediately on the outbreak of war rallied to the standard which was set up with the utmost expedition. We have been in England as you are and always have been in America, peace-loving nations, practising the arts and enjoying the fruits of peace. But we had no choice as to what we should do when Germany violated the sanctity of Belgian territory. If England stands for anything she stands for the sanctity of those treaty obligations which Germany

violated, and which regarded only as scraps of paper to be torn up when she so desired. She stands for justice and its administration. She stands for the rights of small nations and by reason of these ideals we have kept our Empire together by cords which were invisible but which have borne, as you know the strain of this war in a manner which nobody three and a half years ago would have credited as being possible.

We entered the war with our contemptible little army and though we have buried our dead in thousands and though we have taken back to England our wounded in hundreds of thousands—I could even say a larger figure—the Nation has not regretted for one single instant the action that we took in August 1914. We have never doubted that it was our duty to go on we have never questioned the infamy that would have attached to us if ever for one instant we had swerved aside.

Germany as you know planned this war with all the care that Germany can bestow upon matters of this kind. She timed the war we realised now with absolute certainty for the beginning of August 1914. The miracle the unexplained miracle, the inexplicable miracle is that she has not won the war and did not win it outright.

After the second battle of Ypres, we were given time for rest and recuperation. We were given time to make preparations to fight them and we were also given time to realise as we had never realised before what the German menace really meant. We had to learn something of the bestial indifference of Germany to anything that can be called the rights of man.

We had to learn with stupefaction and dismay of the craft and the cruelty that seem innate in the German nature. We had to learn, as we did learn in February 1915 of the hideous malignity of the submarine peril and the submarine morality of the German nation and horror was piled on horror during those months of waiting. There were arson, and plunder and rapine, and lust and every form of hate. Germany launched against us her whole apparatus of infamy and finally there came the tragedy of Miss Cavell. Now an Englishman thinks and you think too of course, that it is a most infamous outrage to lay a hand on any woman, but it is sacrilege to lay hands upon a nurse.

And so the weary months and years of the war went on for us until at last the challenge was thrown to America and you in America learned of the contempt that Germany had for you. You are now calling as we have for a long time the hate that she has for you. But it is a great compliment the German hate, for her hate is the other side of fear.

And America came into the war. But as you know America had been in the war for a long time before that. In the early months of 1915 I went to Paris and I found my old friend Cille hard at work. In March of this year, before you were in when most of the world, in Germany thought you were never likely to come in the French Government did

me the honor of sending me to Verdun and I went through the whole of Verdun the most glorious and sacred soil in Europe.

I walked through Verdun and found it a city of the dead. Verdun was destroyed but the houses were standing the ends of some of them blown off the roofs of some of them blown off and others burned down. But most of the houses or parts of them at least seemed to be there and one did not realize until one had walked through the streets for a few minutes that it was a city that was dead. There was nobody in it at all. The echo of a foot step made a blue coated poilu put his head out of a cellar just to see who was coming. I walked about Verdun and beyond the town up toward the firing line and at the most advanced point I reached, I went down into a cellar to a dug-out excavation and there I found an American ambulance which for over twelve months had been incessantly under fire such fire as up until the last few months the world had never believed it possible to witness. I found a band of young happy cheery Americans doing their best for what they told me was just as much their fight as mine.

And now that you are fighting Germany the first thing that I would beg you always to carry in your hearts never for one instant to let it go from your recollection is that Germany is a great and a powerful nation. She has an implacable hatred both of you and of us. In fact I do not know to whom she now casts her highest favor but you may be sure in this war with her reserves which come up fresh at the rate of a million and a quarter every year she will use against you and against us every dirty device that she can think of and everything which the tortured ingenuity of her mind can contrive against you.

A question that I have often been asked since I came over to America is: When is the war going to end? I believe America will find as we have found that for her the war will begin when every man of military age in the whole country has offered

his services and is prepared to surrender his life for his country when upon the high altar of your patriotism you have reverently laid your wealth your lives your honor and your souls when some day you welcome home the bodies of your most honored dead and when you see moving about your streets as we do at home those relics of humanity who have offered their lives and given their limbs or their health that your homes might be safe.

My great hope from this war now that America and England stand at last side by side is that many of the stupid, petty and miserable little differences between us which were never really of serious consequence shall disappear and that as you and we walk together through the furnace of affliction, we shall be welded together for a united purpose the uprising of a spirit of freedom and liberty in all other peoples and that we shall be sponsors together at the new birth of freedom.

The quotation oftenest made I am sure by Americans since this war began is the famous remark made by General Sherman. I have seen something of it and I can tell you of my own knowledge that War is hell. But there is a hell of suffering and a hell of shame. We have walked through the hell of suffering. We have been scorched by it and our hearts have been seared by it but we realize that after all, the effect of it is purification.

But there is also a hell of dishonor that would have burned in the soul of every man of us if in this great testing time of our race we had turned aside and had been false to the glorious traditions which we have inherited.

Some day — it is not a near day — but some day the sun of righteousness and justice and truth and freedom will appear and throw its blazing full heat upon all the peoples of the earth. That sun has not yet risen. It is still almost night or it may be that we are now only in the cold clammy hours that herald the morn and already as we look out toward the east and across the ocean through a heavy grey mists, there is a promise of the dawn.

## THE WORK OF THE AMERICAN UNITS IN FRANCE

By MAJOR GEORGE W. CRILE, M.R.C. U.S.A.

**D**URING my service in France I heard no one express the opinion that the enemy was wavering or that he was starving that he was short of munitions or that he no longer fights a hard fight or that the Imperial Power is crumbling.

I have seen and talked with many German prisoners. They were strong robust, and mature. They were well clothed and well shod. On the other hand I have heard from hundreds of British soldiers that when the Briton and the Teuton meet — man to man — that the Teuton surrenders — this merely shows good judgment!

I know the British and the French now have the superiority in guns and in munitions. *The British and the French are Top Dogs Now!*

As to the duration of the war everyone in France takes it for granted that the war will be long that it is perhaps half over. The opinion that the enemy is weakening that he is nearing a collapse that he is on the brink of revolution in short, that the war is almost over I have heard only since I landed in New York. This shows how successful is the peace offensive that Germany is waging against the United States.

We hear the high appeal of the President the

appeal of the Council of National Defense, and the appeal of patriotic citizens to us to subscribe to the Liberty Loan to conserve food to relinquish luxuries to put on the uniform but while these energizing appeals enter one ear the enervating word of Peace is whispered into the other by our enemy. To speak of peace now seems as inconsistent as it would be for the Allies to throw an antidote after each gas shell. Germany has all but convinced us that here has been the Empire of Peace that she wanted peace and that she will soon open universities to teach peace and good will to a wicked world.

One day Amsterdam tells us the German navy is in mutiny—the next day it delivers a terrible blow upon an Ally. One day Switzerland tells us that the people of Germany are rising in their might to overthrow militarism and the next day they subscribe a three billion loan for the continuance of militarism. Any day we may hear from Amsterdam that the ruthless submarining was not done by the peace-loving German navy but by the Swiss navy.

For the last six months it has been my great privilege to be in the service of the allies for the Lakeside Unit to which I belong and which was assigned to service with the British Expeditionary Forces. My comments therefore, must refer largely to my experience within the British lines, though from what I have seen of the French I believe that had I been assigned to them my experience would have been no less illuminating nor less advantageous.

From our cordial and helpful reception here by the accredited representative of the British Army, Colonel Goodwin to the reception of the Lakeside Unit upon its arrival in London, and its reception upon its arrival within the British lines in France, every point of contact with the British officially as a unit and unofficially as individuals, on the part of medical officers, nurses and privates was so sincerely cordial, so constructively helpful, that we were readily given possession of the knowledge gained by a great profession in three years' extensive military experience.

It is to the credit of our Surgeon General that his department was so well organized and his hospitals so mobile that the medical department of our army was the first to enter the active field of war.

The plan of organization of the base hospitals of America by General Gorgas and by Colonel Keane has proved most satisfactory under the test of actual field service. The following six base hospital units are serving under the British Expeditionary Forces: the Northwestern University Unit, of Chicago under Dr. Bentley; the Presbyterian Hospital Unit of New York under Dr. Brewer; the Harvard Unit of Boston, under Dr. Cushing; the University of Pennsylvania Unit of Philadelphia, under Dr. Hart; the Washington University Unit of St. Louis, under Dr. Murphy;

the Lakeside Hospital Unit of Cleveland, under Dr. Crile.

These six American Base Hospitals have taken over British hospitals ranging from 1600 to 2000 beds each. During their six months' service the personnel has been engaged in research and in studying methods and organization. They are learning from masters of surgery and of medicine, from masters of sanitation and of research.

These base hospitals have also thrown many surgical teams forward into the front area for service in the casualty clearing stations. Here these surgical teams operate—eat sleep and dodge bombs—then operate—eat sleep and dodge again.

In addition to these units there are several hundred younger men in the front area, serving in the field ambulances and attached to divisions of the British army. These men are always under fire. They frequently shake hands with fate. I need not tell you that they stand by their posts and perform their tasks bravely. We know them too well to doubt that. When they return we shall find them matured—we shall find them sobered and seasoned. They will be men of whom we all shall be proud.

#### WHAT HAS THE BRITISH MEDICAL SERVICE ACCOMPLISHED

They have kept their vast army that vast army that lives like amphibians in the chill water and mud of Flanders more free from colds than pneumonia from typhoid, than your civilian population of Chicago. They have made a medical organization so perfect that their transport has never failed in a single instance under the exigencies of many battles. Through perfection of organization, through research and surgical experience, through the invention of new instruments and apparatus of new methods and new technique, the death rate from wounds, operations and infections in the British and French lines is reduced to an incredible minimum.

Limbs and functions have been restored and a large proportion of all the wounded has been promptly returned to the firing line. Thus a vast army of soldiers has been returned to active service, soldiers who wear the sign of having been wounded—a badge of honor indeed to British and French surgery.

But the long pull of war service, with its single train of thought, its single set of problems with its barbed wire limitations of privilege, made by military necessity—this long endurance of friendly imprisonment has made its impression upon this band of workers—a band remarkable for intelligence, patriotism, devotion, strength of body and of mind—a picked group of differentiated young surgeons who most some day become war weary. Unless relieved in time their initiative will be handicapped and they will be forced to wonder what is to become of them after the war!



RUPERT BLUE M.D. D.Sc.  
Surgeon General United States Public Health Service





I went to France as a novice in military surgery. Let me give you a few impressions. My duties took me, at various times during the summer, through beautiful Normandy into shell-riddled Flanders. I first saw the blossoms growing. I saw grain and maturing fruit. I saw the harvest. I saw many villages and towns and cities. Every where I saw meager power — meager horsepower — meager gasoline power — meager coal and wood power. Of human power I saw only the feeble power of childhood and the waning power of advancing age. I saw the aged men and women stumbling at their tasks in the fields. I saw the soft hand of childhood gripping the hard wheels of toil. The strong men were at war or were dead. The strong women were in the munitions factories. When the children closed their weary day of toil they took their frugal meals and secured their rest and sleep in chill, cheerless houses within sound of the enemy's guns. And why do they thus toil? For power! Power to keep their war machine alive!

When I disembarked in New York a few nights ago from a darkened ship it seemed as if the city must be afire so stupendously excessive was the glow of light. In my taxicab I read by the light of the advertising signs the newspaper appeal to the American nation to conserve its coal and light for her Allies. It seemed as if as much light was being wasted in advertisement alone as is used in all of France for maintaining life. If we have heat and light and power to thus throw away — why not throw it across the sea to lessen the chill and darkness of France.

#### WHAT IS A WAR MACHINE?

A war machine is a vast mechanism — a mechanism miles in depth and miles in length — a mechanism which includes within it iron and steel and copper and lead and aluminum oil petrol glycerine and the nitrates. It includes the hides of animals and the fleeces of sheep the timber of the forests and the destructive elements of the earth and of the air. It includes grain and fruit and flesh. It includes cotton and hemp. It includes all that sustains man, all that clothes man, all that maintains the health of man and all that gives him power to maim to exhaust and to kill. It includes the produce of every field, of every forest and of every mine. It includes things created through the labors of millions of men and of women and of children. When the materials of this war machine are assembled it occupies the highways, the fields of the earth below and the sky above. One part of the machine blasts and breaks and tears terrorizes and kills the other part conserves and disrobes, assuages and relieves, reclaims and rebuilds. This is the medical part, our part of this war machine!

At the present moment the demands upon surgery are unsurpassed. Men are inflicting upon each other every conceivable injury. The world has

become one vast hospital. A new set of surgical problems has arisen. These new problems should be solved. We must abandon our more personal interests — we must think and act in terms of a wounded race. Many surgeons will be called to leave their civil practice and devote themselves to doing for the wounded man what has been done for the man with tumors and ulcers and deformities — what has been done for the gall bladder the appendix the stomach the intestines the thyroid. The same intense devotion by the same class of surgeons toward the problems of the wounded soldier would do for these fellow citizens to whose sacrifice our national destiny is committed what has been done for the civilians who remain at home. It is a serious mistake to suppose that military surgery is the surgery for the unskilled. Civil practice demands perhaps finer dissections but military surgery demands a deeper knowledge of principles a greater versatility. It demands the ability to stand by on twelve hour shifts and to meet every variety of surgical problem of the head the neck the abdomen of joints of the extremities of the chest as well as hemorrhage, shock, exhaustion, and gas gangrene in kaleidoscopic sequence. What surgeon is too able to do these? Can any man perform these operations meet these problems better than the wounded soldier deserves?

The highlights of war surgery are romantic, for in a brief season whole areas of the body are conquered great principles are worked out foundation stones are laid. During battles patients come in volleys. The surgeon is barraged with fractures he is shelled with broken heads, bombed with bellies gassed with wounds. If he is interested in any subject and says so, the stream is turned on him day and night until he surrenders. If he wants postmortem material, he chooses from the daily pile. If he desires transfusions he keeps a stream of blood flowing from donor to recipient day and night. More progress has been made in the surgery of the chest and abdomen in the treatment of wounds of infections of hemorrhage and exhaustion more knowledge has been accumulated of splints of apparatus and of every applicable mechanism in the brief three years of war than in the past generation. Every day witnesses a new evolution. The best talent of the world is concentrating on the battle line. Do you want to render a service equal to that of putting 100,000 well trained soldiers in the field? Then discover a method of abolishing lice and itch from the armies, discover how to prevent trench fever and trench nephritis — and one-half of the invalidism of the army will be abolished. The cost of killing men has constantly risen until now it probably costs more than \$100,000 to kill a man. When, through medical discovery thousands of men can be saved — what more romantic service can there be than to play the great game of preventive medicine for such a stupendous stake?

The present war is a contest of ideas rather than of men. In its broadest sense, war is the practical application of physics, chemistry and biology in a mass struggle for the existence of nations. The battle itself is the applied science of killing. The group that will survive will be the group that will

furnish the most effective ideas and men. Today so terrible is the menace of the correlated sciences of our able enemy that our first line trenches must also include our scientific laboratories. Only by throwing into the arena our intellectual as well as our material forces, will we achieve survival.

## THE SURGEONS OF THE ARMY

B. SURGEON GENERAL WILLIAM C. GORGAS U.S.A.

I WOULD like merely tonight to introduce the general subject of the work of the military surgeon and leave the elaboration of the subject to the gentlemen who will follow me.

In our situation at present the subject is a most interesting and important one and of course to the Medical Corps of the Army of paramount importance. My personal experience in military surgery is nil. I am one of those unfortunate soldiers who has been in the Army for forty years, but has had the misfortune to hear only those hostile bullets that were fired in our little Spanish American War.

Since that time military surgery has practically been born over again. This great war has demonstrated the fact that we will have to add enormously to those procedures that were recognized and adopted before this great struggle came.

It would hardly be appropriate having had no

personal experience in the present war for me to call attention to the matter but I have heard it so much discussed and read so many reports on the subject and been so much interested, that I think I might venture to say that the whole question turns upon the problem of sepsis, the endeavor of the military surgeon to get at the wound as quickly as possible in the effort to keep it free from infection or if it is already infected to restore it to normal in the shortest possible time. The principal rule of the Army administrator will be to arrange affairs so that the surgeons in immediate charge of the wounded can get about to accomplish these things at the earliest possible moment.

With this object in view we should have all our hospitals all our arrangements for caring for the wounded, made as close to the front line as possible. All our plans and energies will be bent toward this central object.

## THE SURGEONS OF THE NAVY

BY SURGEON GENERAL WILLIAM C. BRAISTED U.S.N.

I HAVE been requested to talk to you for the next few minutes on Surgeons of the Navy. I feel justified however in taking this opportunity to talk to you on the more general subject of the Medical Department of the Navy and to endeavor to present to you briefly our status as it was before the outbreak of hostilities the expansion which has been found necessary and the present condition, both as regards personnel and material.

On April 6 there were 64,680 enlisted men in the regular Navy now there are 143,726 an increase of 79,046. The Naval Reserve Force has increased from about 10,000 to 40,000. A 500 Naval Militia are in the Federal service the Coast Guard with its force of 5000 has been transferred to the Navy for the duration of the War the Hospital Corps has been increased from 1,000 to 6,500, the Marine Corps has increased from 13,666 enlisted men on April 6 to an enlisted strength with reserves of about 33,348 there are about 1,000 officers in the Navy and 1,000 in the Marine Corps. The Navy and Marine Corps now constitute a force of more than a quarter of a million men.

The Medical Corps of the Navy on April 6 contained 304 commissioned officers today it has 828 officers, either commissioned or awaiting commission, this being the full authorized strength of the Medical Corps as allowed by law. The comparatively limited age requirements for the Medical Corps 16 to 32 years of age, have necessarily prevented the acceptance of thousands of patriotic officers of service by medical men throughout the country for duty with that corps. I am very glad to say however, that those candidates who have been secured to fill these permanent positions are of an unusually high type of training and general excellence redound to the credit of our medical schools and I hope and believe will continue to be a credit to the Medical Corps of the Navy.

In order to meet the urgent need for men and to assure the quality of the material, a campaign was instituted early in this year among the class "A" medical schools of the country and the advantages and opportunities of a naval career were presented to the prospective graduates of the senior classes. Only candidates who were certified by their deans

as being of exceptionally high standing in their school careers were offered the opportunity of qualifying for naval service. Some 329 officers were obtained for the Naval Reserve Force in this way and of these about 70 per cent have been found qualified and commissioned in the Medical Corps of the Navy. While these young men have necessarily lost some of the benefits to be derived from post-graduate internships in the civilian hospitals it has been my effort and will continue to be so to provide them such duty as will furnish them opportunities in their naval service equal to those that they have relinquished.

As this increase has presented itself as practically one increment it was found impossible to put those young officers who were prospective candidates for the permanent service in the Medical Corps through the Naval Medical School in one class we therefore with the enthusiastic assistance of the teaching staffs of the medical colleges of our larger centers instituted courses of instruction for these officers in Boston, New York, Philadelphia, Chicago and San Francisco as well as at the Naval Medical School, Washington D C. We have been thus at a very rapid rate converting this material of excellent professional training but unused to Navy routine into medical officers of initiative and self reliance who will be well qualified for the routine of independent duty when the necessity arises. Abundant bedside work is provided by our naval hospitals as well as by the civilian hospitals connected with these teaching institutions.

I am very glad to say that the offers of services from the medical men of the country for duty in the present emergency have been far more numerous than the Navy could utilize. Owing to this fact, an effort has been made to restrict the acceptance of such offers of service for the Naval Reserve Force to the relatively younger men with considerable recent hospital experience. In addition to 828 members of the Medical Corps of the Navy we have now available for active detail over 700 members of the Naval Reserve Force, 74 Medical Reserve Corps officers, 24 acting assistant surgeons, 96 retired officers, 77 National Naval Volunteers and Naval Militia officers and 21 medical officers of the Coast Guard—a total of approximately 1800 medical officers.

Owing to the possibility of limiting our acceptance of services to young internes there has been no question of the appropriateness of enrolling all in the grade of assistant surgeon. No advanced ranks on appointment from civil life have been issued except in connection with Red Cross duty and thus much of the embitterment which might have been encountered has been obviated.

I believe that in these comparatively youthful energetic, and ambitious younger men, fresh from the abundance of bedside, operative and laboratory work, which is available in our great modern hospitals the Navy has secured the finest and most appropriate material for the varied problems to be

encountered in naval life. In the numerous small or large scattered units that constitute our floating force our medical officers must necessarily themselves handle all cases encountered and unless in the vicinity of a naval hospital cannot do what their colleagues in civil life would do refer a troublesome case to a specialist.

As I have referred to the American Red Cross I will state here briefly that the Navy has at present 12 hospital units organized under and in conjunction with the American Red Cross—5 large Navy Base Hospitals and 7 smaller Naval Station Hospitals the majority of which are now on active duty and rendering helpful and efficient service.

The Hospital Corps of the Navy our nursing force which numbered less than 2000 before the outbreak of the war now has in active and reserve force of some 6500. Four Hospital Corps schools are maintained by the Navy and these have been working at high pressure to handle this new material obtained. Special methods of instruction for the hospital corpsmen serving with military forces have been undertaken with a very satisfactory degree of success in view of the short time that has elapsed. Improvement in this type of training is looked for now that experience already gained in France is being utilized in this training. During the coming months the course of instruction at the Hospital Corps schools will be gradually increased again until it reaches the normal period of six months. The medical service for the care of our men ashore and afloat has been rapidly and satisfactorily expanded and has more than kept pace with the increased personnel in a way which has been gratifying. From the smallest detached unit to the largest naval center the appropriate facilities and accommodations have been provided for the care of the sick and wounded and for the prevention of disease. Extensive emergency hospital construction has been provided where the existing naval or civilian accommodations did not seem to meet the current or prospective conditions.

The Public Health Service has been most courteous in its co-operation with the Navy and sanitary inspection has been made at all Naval Stations by officers of that service who have been transferred to the Navy for duty and assigned one to each Naval District. Sanitary surveys have also been made of the zones surrounding Naval Stations and of the towns or cities in which section bases, training camps aviation schools etc. are situated. Efforts are being made to meet winter conditions by putting in force the required sanitary measures before the advent of cold weather.

Three hospital ships are now under construction for the Navy one commenced last year being new construction the other two being converted from passenger-carrying vessels. None of these however is as yet available and it will be some months before that can be the case. Our older hospital ship the U S S Solace has been of tremendous benefit during its entire service in the Navy and

particularly so at the present time with the crowded condition of the fleet. The ambulance ship *Suri* which was so generously provided by Dr. John A. Harris of New York City proved of great service in relieving the stress imposed upon the *Solace*, in evacuating the sick from the fleet to the nearest hospital base.

In closing these few remarks I want to express to the medical men of the country my sincere appreciation of the high spirit of patriotism that has been

demonstrated by our profession. No class of men has been more prompt in its response to its country's needs and no class has in doing so been so self-sacrificing as the medical men of our great country. And through the sacrifices, inconveniences and hardships, not only of themselves, but of those whom they have left behind, they have upheld the dignity and prestige of their great calling and have emphasized once again their adherence to the tenets of their Hippocratic oath.

## THE TRAINING OF MEDICAL RESERVE OFFICERS

By COLONEL EDWARD L. MUNSON M.C. U.S.A.

THE outbreak of war found the United States possessing approximately only 500 officers well qualified to conduct the work of the Medical Department. This number included all regulars of more than one year's service and the best of the National Guard and Medical Reserve Corps.

Existing law officially recognized the need for seven medical officers per thousand strength, and the British experience was that ten per thousand were needed for all purposes.

As Congress had provided for the recruiting of a total force of 350,000 men it was clear that some 8,500 doctors would be needed for such force. On this basis, one could regard 18 per cent of our necessary medical personnel as trained and 82 per cent as untrained in whole or part.

Some idea of the task confronting the Medical Department may be gained from the facts that for the medical service alone, of the military forces authorized by Congress, the medical personnel, officers and men, would approximate a quarter of a million, or about twice the total strength of the entire army of the United States the day war was declared; that commissioned medical officers and dental surgeons alone would approximate in number the entire strength of our regular army at the outbreak of the war with Spain; that hospitals would have to be provided and administered in capacity sufficient to give a hospital bed to every man, woman and child in a community like Kansas City; that the ambulance companies and field hospitals marching with fighting troops would occupy a road space as long as from Washington to Philadelphia; and that the present annual appropriations for medical facilities and supplies would exceed that for the entire Army a year ago.

It seemed evident that the Medical Department would be quite unable to carry the burden about to be imposed upon it, unless this vast mass of willing, able, but raw professional material was promptly taken in hand and its members systematically and intensively trained in military methods, purposes and environment, and the effect which these would

have upon professional practice. It was clear that, in order to reduce the results of lost motion, friction and ignorance, the medical personnel would have to be organized, merge its individuality in a vast machine and be familiarized with the operation of the latter.

For this purpose the Surgeon General asked and received authority for the establishment of four great medical training camps, much on the order of the citizens training camps in organization and administration. One of these camps is at Fort Benjamin Harrison, near Indianapolis; another at Fort Riley, Kansas; another at Fort Oglethorpe, Georgia; and a fourth at Leo Springs, near San Antonio, Texas. The last named, however, was never organized due to inability to provide instructors as a result of pressing need for medical officers elsewhere.

The above three camps each have accommodations for approximately 1200 medical officers, and some 3,000 enlisted men of the Medical Department.

In addition, a camp for colored medical officers and men was established at Fort Des Moines, Iowa, with about 50 colored medical officers and 1000 colored enlisted men in attendance.

A camp for the U. S. Army Ambulance Corps, a special organization for service with the French Army, was started at Allentown, Pa., with a capacity of 50 medical officers and 4500 enlisted men.

Finally at Fort Ethan Allen, Vermont, a camp primarily for the training of enlisted men, was developed with about 50 medical officers and 2000 enlisted men of the Medical Department.

At the present writing then the Medical Department has some 3000 doctors under instruction at medical training camps, with some 16,500 enlisted men, or a total of some 20,000. To this must be added the larger number of medical officers and men already on duty in divisional camps and cantonment hospitals and receiving systematized instruction in addition to performing daily duties.

In a general way the medical men sent to these camps are for physical reasons, under forty-five

years of age. As they are to serve in the field with fighting troops and handle large bodies of men and wounded, they must have physical stamina, force of character, quick judgment, sound decision and ability to command confidence of officers and enlisted men alike. These qualities the camps inculcate.

Older men, professional experts of long experience and leaders of the profession, find their greatest usefulness in purely professional duties in fixed hospitals and other formations in the rear. They are not ordinarily sent to training camps except at their own request.

The new arrivals at the medical training camps are good doctors but wholly ignorant of the additional qualifications required of medical officers. How raw the medical recruit is may be inferred from the fact that, duly instigated, they cheerfully go on errands of the adjutant for the 'keys to the store tent or to the Quartermaster for thirty yards of skirmish line. One entire company of medical officer "rookies" missed a review because some wag entered their barracks and announced in stentorian tones that it looked like rain and that the company should send forthwith to the Quartermaster for an issue of olive drab umbrellas -- which the guileless company proceeded to do.

There seems to have been in some quarters some doubt as to the nature and purpose of these medical training camps. They are not professional schools. The doctors accepted for service have already been examined and found competent as practitioners of medicine and surgery. What the camps do is to fit such practitioners for military service and particularly for service in the front line with fighting troops. It usually takes the new recruit about a fortnight to understand this purpose and its necessity. Training is physical, military, disciplinary and professional.

Bearing in mind that these camps are training officers especially for service with fighting troops, much stress is laid upon the development of high physical efficiency. For in the absence of high physical powers and ability to support fatigue and privation, it is clear that mere professional excellence would have little value.

The medical officer must be able to march as far and live under the same conditions as the line troops with whom he serves. During the fight, he shares all its dangers and hardships. After the fight is over and the line troops can have a rest, is the time when the medical officer faces his heaviest task. There is no place for the medical weakling at the front. He must do all that the line troops do and then his special professional work in addition.

For this reason, the curriculum starts in each day with fifteen minutes setting up exercise, and includes three hours of drill, marching or equestrian. The physical improvement manifested in the average doctor in a few weeks as a result of this training is remarkable. He arrives soft, flabby, often somewhat paunchy of bad posture, a creature

of the automobile era, unable to ride or march. He leaves erect, firm and muscled, well set up and able to do in marching whatever the needs of the service may demand. His waist measure has decreased from two to seven inches, his chest has filled out and in Navy parlance he has shifted his ballast. He feels better than ever in his life and additional years of vigor and usefulness have unquestionably been conferred on him.

This physical training is carried out under doctors experienced in physical training and is graded to the individual. For example, the physical training at one camp is conducted by medical officers formerly physical directors at Leland Stanford University and of the Y M C A of St. Louis. It includes setting up exercises, marching and other drills, hikes and equestrian. This physical training continues throughout the entire course of three months.

The military special training of the first month is basic. It includes much that the medical officer will never have to do himself -- as transporting wounded, putting up tentage, handling of equipment, etc. -- but which he will have to teach enlisted subordinates how to perform. Before the War, non-commissioned officers did most of this work. Most of these experienced men have been promoted and for practical purposes this class of 'shock absorbers' no longer exists. The medical officers will make them later from present raw recruits. In the meantime, the medical officers must do their duty as instructors of enlisted men. They can only do it through learning it and they can learn it best by actual performance of each task that they will have to instruct their subordinates to perform. For this reason, the camps are organized on a cadet basis through which medical officers pass as privates, corporals and sergeants before becoming organization commanders. There is much competition for such promotion, and it is the rule that the successful men here are the successful men in civil life. Of a certain bunch of fourteen corporals made, it turned out that ten were professors in medical colleges.

The handling of men, the maintenance of discipline and order, the psychology of the soldier, the direction of large organizations and masses of unitary groups which is indispensable to team efficiency is taught by actual practice. Doctors seem particularly quick to grasp both the importance and methods of such work.

Following instruction in the work of enlisted men, which lasts about one month, the doctor takes up his work as a medical officer. He learns how to handle efficiently regimental detachments, ambulance companies and field hospitals by actual detail with them. He administers them, camps and marches with them and handles them in problems and maneuvers. This is live, active work, which appeals to many men and is made as much like real conditions of war as circumstances permit. It is astonishing how many shining lights of the

profession become enthusiastic students of the psychology of medical pack mules or the mechanics of the insides of motor ambulances.

In the first and second month the newly fledged officer learns Army regulations and the prescribed business methods of the Medical Department and other branches of the Army. He learns the relation that he and the Medical Department bear to the rest of the Army. He learns paper work by actually making out all papers and submitting them to a censor, whose blue pencil is ruthless.

In the second and third month, he takes up professional matters where these are modified by military environment.

As the average civilian practitioner has a limited knowledge of hygiene, much attention is given to this in the form of the hygiene of troops and practical applied camp sanitation. The care of troops is a subject of such basic importance and constant application that it cannot be overemphasized.

A course of reading lectures, and some demonstrations are given in such elements of war surgery as differentiate it from ordinary accident surgery of civil life. (As equipment has just become available and much attention will be given to gas protection and the treatment of gassed cases. Shell shock, the war neuroses and psychoses trench foot diseases common among troops on the Western front malingering etc. complete the professional subjects which are covered. Postgraduate courses qualify selected officers as sanitary inspectors as commanders adjutants and quartermasters of hospitals as directors of ambulance companies and field hospitals etc.

After finishing the basic instruction selected enlisted men are qualified by special courses as non-commissioned officers clerks, cooks dispensary and surgical assistants ward nurses drivers chauffeurs gas engine men, etc.

These training camps are now turning out in excess of thousand well qualified medical officers monthly and several thousand enlisted men, a large part of whom are potential non-commissioned officers. In a single day these training camps sent to each of fifteen camps of National Army divisions, a solid train load of medical officers and enlisted men, 400 in number divided into hand picked detachments for each regiment, ambulance company and field hospital so that they were going on terms with the line organizations with which they were to serve were on the ground.

After completing instruction at medical camps, officers and men are assigned to service with troops. This merely means a continuation of training. Any defects in medico-military education are remedied. But the special feature of this second course is the training in their respective special lines of work given the medical officer group of the division and adjoining base hospital by the selected specialists and experts attached to such hospital. In this course the medical officer is brought back again to his profession and is taught the advantage of professional teamwork and the utilization of the specialist.

In a series of seminars conferences, clinics and demonstrations, the X-ray expert, for example, shows how roentgenology can best be utilized by the general practitioner in the Army the laboratory man how the laboratory tests contribute to precision of diagnosis the orthopedic surgeon explains the functions of his specialty the internist discusses the diseases specially common in the trenches etc. All this not with a view of making a specialist of the average medical officer but to demonstrate to him the advantages and methods of professional teamwork, as modified by the necessities of military service. This second course of advanced and professional training is already ordered to begin on November 1 in thirty-eight divisions and cantonment hospitals where it will affect some 5,000 medical officers.

A third plan of training which is had in mind, is later to give a course in purely professional clinical instruction, in the wards of great military hospitals, to those whose clinical education in civil life has not been as extensive as is desirable.

The training scheme as a whole thus not only plans to qualify doctors as medical officers, but to make them better doctors.

That the results of the foregoing training have borne out the anticipation is shown by the fact that division surgeons and others uniformly peak of the far greater efficiency in the service of the officers sent to them from medical officers training camps, as compared with those direct from civil life. They have assumed their new duties with confidence and ability. The line officers most favorably comment upon it. Finally the medical officers who have been graduated from the training camps themselves realize the great practical value of their instruction, and are writing back very many letters of appreciation and thanks to the staffs of instructors.

## LABORATORIES IN THE ARMY

By COLONEL F F RUSSELL, M.C. U.S.A.

THE subject of laboratories in the army is one which does not lend itself to much that is either new or novel. A description of an army laboratory would not differ materially from that in a civil institution.

At the present time, we are confronted with the process of expansion rather than with the introduction of new principles. None of the problems confronting us in this country is new in principle although the association of very large numbers of young men of susceptible age will no doubt force us to find simpler and less cumbersome methods of control of infectious diseases than we now have. Our efforts will be to put into practice everywhere the principles which we now carry out effectively only in our larger cities. Since the days of General Sternberg every military hospital has been provided with a suitable room and a standard outfit of apparatus for laboratory work. In 1893 after the World's Fair here in Chicago the Army Medical Corps exhibit was sent to Washington and with that apparatus as a nucleus an Army Medical School was started under Major Walter Reed, who had James Carroll as his assistant. At its beginning the school consisted merely of Walter Reed's laboratory. As time went on the present Army Medical School grew up around the laboratory which has always remained the principal part of the course. Walter Reed and his successors have trained all the new men in the regular corps since 1893 with the exception of two years—the time of the Spanish war.

Our next step was taken about 1909 when the department laboratories were first organized to meet the call for more specialized technical service. It had been shown that it was not enough to fit up a laboratory in every post hospital that there were many sorts of work requiring a high degree of technical skill, which could be done by special laboratory men and that the general surgeon and the general practitioner had neither the time nor training to make the newer tests. Department laboratories have been established now from time to time and they are now working in Manila, San Francisco, San Antonio, Atlanta, Fort Leavenworth, Washington, and Ancon Canal Zone. Since last spring these institutions have expanded greatly and all are now large institutions with staffs of six to twenty men or more. Up to the present time they have been our principal reliance for technical work, and will continue to be until the new cantonment laboratories are working smoothly. In these laboratories, we have done Wassermann and other complement fixation reactions since 1909. Most tissue examinations, all the medico-legal work and many of the water examinations, blood cultures and typhoid

carrier work have been made in such places. It is possible to summarize the scope of the work of the department laboratories by stating that they have done all and any sort of laboratory work which could be done with specimens sent through the mails.

The new work has been the establishment of new and adequate laboratories in the semi-permanent cantonments of the National Army and National Guard and at the general hospitals which are gradually coming into being at the older army posts throughout the country.

The new cantonments have a population of from 10 to 40 thousand or more with a camp hospital large enough to care for 3 per cent of the population. The laboratory therefore must be able to handle the public health work of a community of that size and also to do the clinical laboratory work for a large general hospital.

The problem of equipping and developing a laboratory is never a simple one—even in times of peace. The demand for laboratory furniture is not great and apparatus and many articles have heretofore been imported from France and particularly from Germany. The most difficult problem therefore has been to obtain apparatus and reagents in sufficient quantity. The original list of supplies called for an expenditure of about \$2000.00 for each of fifty places and the construction of a special building for laboratory purposes at these hospitals. The principal articles have been delivered at all cantonments and additional supplies are being furnished as rapidly as they can be manufactured. Good men have volunteered and have entered the service in large numbers and at the present time, it is possible to furnish three to five trained laboratory men to all of the laboratories. In the future, it may be difficult to do as well and recourse must be had to the many trained laboratory workers who have not the degree of doctor of medicine. A way has been provided, through the newly created Sanitary Corps, to use the services of these trained men to the best advantage. In this country when it becomes necessary the Army can also use the services of the many highly trained women laboratory workers as civil service employees. Many have already volunteered, and when the time comes they can help materially in our work in this country.

The character of the work done in these army laboratories will not differ from that done in civil institutions. A manual of technique is being published which will help to standardize the work done in widely separated parts of the country. The work of the laboratories will fall naturally into two classes: clinical pathology for diagnosis in connection with the work of the surgeons and internists in the camp hospital, and public health work for the



sanitary inspectors with the troops that is routine water examinations the examination of carriers of typhoid and meningitis and other infectious diseases. On item alone of this public health work will serve to show the large number of examinations which will be required that is the detection and treatment of the hookworm carrier from the South. Probably not less than a million examinations for hookworm will be necessary if we are to avoid the introduction of Frank's new disease. Fortunately the hookworm problem is simple and is well understood and our only difficulties will arise from the great amount of work required.

Typhoid and the paratyphoid fevers have ceased to be a great problem in themselves but the mere preparation of a vaccine for millions of men is not a small undertaking. For almost ten years the Army Medical School has prepared all the vaccine used in the service.

All of the larger places have been equipped to make Wassermann test to examine meningococcus carriers and to differentiate the several types of pneumonia. Standard diagnostic sera for agglutination test will be furnished from the Army Medical School to any laboratory. In general way we hope to have the same grade of work done in all the cantonments which are now carried out in the better institutions in the city.

At the present time we have three principal problems confronting every medical officer of the services: the control of venereal diseases, of pneumonia and of meningitis; complete and cordial co-operation of all is necessary to achieve success. The army within its camps has developed a fairly effective method of controlling venereal diseases by

means of prophylactic treatment and disciplinary measures which calls for concerted action of both the line officer and the medical officer. Its success will depend upon the care with which it is carried out and medical officers can contribute materially to the strength of our armies if they will give as much time and care to the treatment of venereal diseases as they are now accustomed to give to less common diseases.

Ahead and at the front the problem is a little different and a large number of small, mobile laboratories have been furnished in addition to those furnished each army corps and each army and to each of the base and general hospitals. In these various institutions provision has been made, first for the routine work, and second for research and we may hope that solution of old problems may be simplified and new problems as they arise may be solved on the spot. Much work has already been done as you know on the new diseases of this war.

In conclusion, I wish to say that well trained laboratory men have volunteered throughout the length and breadth of the land to perform laboratory service or any other service for which men were needed. Research and teaching institutions have also offered unanimously the use of their facilities for work and for teaching and there is everywhere the wish and the will to do everything humanly possible to make our camps and cantonments better than we have ever had them before. All of us who have worked under Surgeon General Gorgas and have learned his methods have come to have confidence in the future of the Medical Corps of the Army under his charge.

## EXTRA CANTONMENT ZONES

By RAYMOND B. FOSDICK,

Chairman, Commission on Training Camp Activities

THE Commission on Training Camp Activities was appointed by Secretary of War Baker in April, 1917, very shortly after war was declared. Its purpose was twofold: to supply the normalities of life to nearly a million and a half young men in training camps and to keep the environs of those camps clean and wholesome.

On May 8, 1917 Congress passed the act providing for the National Army. This act declared that prostitution and alcohol were not only not necessary to maintain this efficiency and morale of the Army but were highly destructive to them. Past experience has proved conclusively that debauchery and loose living among soldiers at mobilization points has in part resulted from lack of opportunities for wholesome amusement. The venereal disease, which has resulted from such misadventure of leisure time has constituted in the past and constitutes today one of the big problems with

which armies must face in maintaining their efficiency. In order to correct these conditions the Commission has devoted itself to the re-establishment as far as possible of the normal relations of life while at the same time delivering sledge hammer blows at those who had mobilized in the communities surrounding such camps for the purpose of exploiting the soldiers by appealing to his baser instincts and passions.

To great extent the Commission has employed in these two important activities the machinery of organizations and agencies heretofore interested along such lines. Except where necessary it has not created any new machinery.

To the Young Men's Christian Association and the Knights of Columbus for instance, the Commission has looked to supply a large share of the club life and entertainment inside the training camps. To the American Library Association, it

has instinctively turned for an adequate supply of books and reading facilities for the troops. To organize the social and recreational life of the communities adjacent to the training camps the Commission enlisted the services of the Playground and Recreation Association of America which has placed representatives in over one hundred such communities and has harnessed the lodges, churches, clubs and other local groups and organizations with the men in the camps. So too such agencies as the Travelers Aid Society and the Young Men's Christian Association have been brought into play in connection with the community problem.

Repressive work in dealing with vicious conditions is handled by direct representatives of the Commission, with whom are co-operating such organizations as the Committee of Fourteen of New York, the Watch and Ward Society of New England, the Committee of Fifteen of Chicago, the Bureau of Social Hygiene of New York and the American Social Hygiene Association. Local police organizations and sheriffs as well as the machinery of the Department of Justice and the Military Provost Guards, have been utilized in this work. The special problem arising from the presence of young girls in the vicinity of the camps is handled by the Young Women's Christian Association and by a Committee on Protective Work attached to the Commission.

Within the camps, in addition to the facilities already mentioned, the Commission has appointed sports directors, boxing instructors, song leaders and dramatic entertainment managers. Theaters are being erected in each cantonment for the exhibition of regular dramatic performances and special facilities have been provided for the production of moving pictures, vaudeville and other forms of amusement. Divisional exchange officers appointed by the Commission, one in each camp, are superintending the operation of the regimental Post Exchanges, or soldiers co-operative stores.

It will thus be seen that the work of the Commission, both in its constructive and law enforcement activities, constitutes one gigantic piece of preventive medicine. The Surgeon General of the Army has so far recognized this fact as to appoint and delegate to the Commission on Training Camp Activities a number of sanitary corps lieutenants who are now stationed in the field and are assisting the Commission in securing the co-operation of communities in this program.

As concrete examples of what has been accomplished may be mentioned the closing of red light districts in the following cities: Deming, New Mexico, El Paso, Waco, San Antonio, Fort Worth and Houston, Texas; Hattiesburg, Mississippi; Spartanburg, South Carolina; Norfolk and Petersburg, Virginia; Jacksonville, Florida; Alexandria, Louisiana; Savannah, Georgia; Charleston, Columbia, and Greenville, South Carolina; Douglas, Arizona; Louisville, Kentucky and Montgomery, Alabama. New Orleans has passed an ordinance

which will wipe out its red light district on or about November 15. Many cities in which no red light districts were formerly tolerated have at the instance of the Commission abolished their open houses of prostitution.

In addition, the laws against vice have been strengthened in many cities at the suggestion of the Commission's representatives, and the machinery for the enforcement of those laws has been geared up to a higher notch of efficiency. In California and Arkansas State Military Welfare Commissions have been appointed by the Governors of those States at the instigation of representatives of this Commission and executive secretaries have been appointed to carry on the work of vice repression.

I am happy to report that in every instance where bad conditions have been brought to the attention of state and municipal officials and the desire of the Government made clear to these officials that these conditions should be improved prompt and cheerful compliance with such requests has been forthcoming.

The whole program for the protection of the officers and men of the Army and Navy from the moral and physical contamination of vice and drunkenness depends to a great extent on the co-operation of the medical profession. Much of the misinformation, under which the average man is laboring originated with those doctors who in the past have advised and medical quacks who still advise men that continence is harmful and that seminal emissions result in lost manhood and that regular sexual intercourse is necessary to health.

The exact opposite is the truth as evidenced by the statement signed by 300 of the foremost physicians of the country which statement was published in the pamphlet entitled, *The Physician's Answer* some few years ago. This statement declared that in the opinion of these physicians there was no evidence in existence that continence was incompatible with health. A still stronger statement was contained in the resolutions of a similar body of physicians called into consultation by the General Medical Board of the Council of National Defense, which statement was embodied in resolutions which were approved by the advisory commission of the Council of National Defense, and finally approved April 21, 1917. These resolutions contained the statement that the departments of War and Navy officially recognized that sexual continence is compatible with health and that it is the best prevention of venereal infections. Two months later the House of Delegates of the American Medical Association unanimously adopted similar resolutions containing the following paragraphs:

*Therefore, be it resolved, That the American Medical Association endorses the actions of Congress and the Council of National Defense, and commends the following for the basis for a program of civil activities:*

*That sexual continence is compatible with health and is the best prevention of venereal infections.*

That steps be taken toward the eradication of venereal infections through the repression of prostitution, and b. the provision of suitable recreational facilities, the control of alcoholic drinks and other effective measures.

These resolutions were passed on June 7, 1917.

In spite of the fact that the vast preponderance of intelligent medical opinion of this country is thus on record that continence is entirely compatible with health, and in fact its only sure guarantee from venereal disease, there are still some doctors, both within and without the service, who believe in the old, worn-out doctrines of self-indulgence.

Prostitution and its twin brother drunkenness are fast becoming anachronisms. In a generation we shall probably regard them as relics of barbarism and wonder how any community could ever have tolerated a system which took such a terrible toll of health, happiness and life itself—that destroyed the eyes of the newborn babe in the arms of its heartbroken mother—that wrecked the health of that mother and made her unable to bear other healthy children—that filled our insane asylums, jails and hospitals and left behind it a trail of social devastation awful to contemplate.

The winning of this war will depend upon the ability of the allies to maintain their armies at a high standard of efficiency. If the American Army and Navy suffer its personnel to be contaminated by venereal disease and therefore incapacitated

for service to anywhere near the extent that the men of this service have been contaminated and incapacitated in past wars, our service to the cause of humanity will be far short of our hopes, because our forces will be seriously depleted, the war will drag on, and thousands of soldiers and sailors will be needlessly sacrificed before we and our allies can force a lasting peace upon the Kaiser.

We are fighting for the safety of democracy. It is our task also to make democracy worth fighting for. Those who oppose us in our war on vice and drunkenness are attempting to make of democracy a synonym for license and self-indulgence which in the end always results in anarchy.

We stand for a democracy which while recognizing man's inherent right to a measure of self-government insists that that right carries with it obligations to the State, most sacred in character. Those obligations require the individual to curb his passions and exercise self-restraint in order that the institution of the family which is the fountainhead of the State and from which spring all of our noblest inspirations shall remain pure and undefiled. I call upon the medical profession both within and without the service to stand by us in this effort to keep the Army and Navy clean and efficient. If social and economic considerations will not suffice to secure this co-operation, I urge it upon considerations of humanity and patriotism.

## THE CONTROL OF VENEREAL DISEASES

B. M. JOSE WILLIAM F. SNOW, M.D., U.S.A.

Chairman, Sub-Committee on Venereal Diseases, General Medical Board, Council of National Defense.

WAR was declared April 5. On April 7 the Council of National Defense adopted the following resolutions after a hearing participated in by the members of the Council, the Advisory Commission, the General Medical Board, and the three Surgeons General of the United States:

WHEREAS venereal infections are among the most serious and disabling diseases to which the soldier and sailor is liable and

WHEREAS they constitute a grave menace to the civil population,

THEREFORE, be it resolved, That the following recommendations of the General Medical Board be approved for submission to the Departments of War and Navy for guidance:

That the Departments of War and Navy officially recognize that sexual continence is compatible with health and that it is the best prevention of venereal infections.

That the Departments of War and Navy take steps toward the prevention of venereal infections through the exclusion of prostitutes within an effective zone surrounding all places under their control, and by the provision of suitable recreational facilities, the control of the use of alcoholic drinks and other effective measures. (By separate resolution, the elimination of alcoholic beverages from camps and surrounding zones was recommended.)

3. That these departments adopt plans for control of venereal infections through special divisions of their medical services.

The first of these recommendations has been carried out through the press and platform on every suitable occasion by the President, the secretaries of War and Navy, the chiefs of staff and the Surgeons General. Secretary Daniels you heard express his opinion of the importance of this problem last night. Secretary Baker in an open letter to the governors of all the states said:

Our responsibility in this matter is not open to question. We cannot allow these young men, most of whom will have been drafted to service, to be surrounded by a vicious and demoralizing environment, nor can we leave anything undone which will protect them from unhealthy influences and crude forms of temptation. Not only have we an inescapable responsibility in this matter to the families and communities from which these young men are selected, but, from the standpoint of our duty and our determination to create an efficient army, we are bound, as military necessity to do everything in our power to promote the health and conserve the vitality of the men in the training camps.

I am determined that our new training camps, as well as the surrounding zones within a effective radius, shall not be places of temptation and peril.

Will you give earnest consideration to this matter in your particular state? I am confident that much can be done to arouse the cities and towns to an appreciation of their responsibility for clean conditions and I would suggest that, through such channels as may present themselves to you, you impress upon these communities their patriotic opportunity in this matter. I would further suggest that as an integral part of the war machinery your Council make itself responsible for seeing that the laws of your State and of Congress in respect to these matters are strictly enforced. This relates not only to the camps established under Federal authority both the present officers training camps and the divisional training camps soon to be opened, but to the more or less temporary mobilization points of the national guard units. It relates too as I have indicated to the large centers through which soldiers will constantly be passing in transit to other points.

As early as 1915 Admiral Branstetter prepared for the Navy with the approval of the Secretary a program essentially along the lines now under consideration. Surgeon General Gorgas in a recent address said

It is the purpose of all the military medical establishments to direct its efforts toward keeping as many men as possible for as long a time as possible in the fighting force. Obviously therefore the medical department of the army is deeply concerned in every effort of education, recreation, law enforcement, and treatment which will reduce the non-effective rate of venereal diseases. These four lines of attack constitute the basis for the program of combating these diseases which will be carried out by the army. It is hoped that the civil authorities will simultaneously place the same program in operation.

In another statement issued by the Surgeon General's office it is pointed out that neither the measures within the military establishment nor the supplementary measures in specified zones can achieve the largest success without the full co-operation of civil authorities in enforcing such equivalent measures in all communities accessible to the personnel of the army. These are but illustrations of the efforts of every chief government officer concerned to place this problem and its solution squarely before the American people.

The second of the original recommendations has been met by Congress through empowering the President and Secretary of War to establish zones about military camps and to make regulations for the elimination of prostitution and alcohol therefrom.

The third recommendation has been met by the creation of the following administrative facilities:

- 1 Commission on Training Camp Activities
- 2 Section on Venereal Diseases of the Infectious Disease Division of the Surgeon General's Office
- 3 Advisory Committee on the Treatment of Genito-Urinary and Venereal Diseases. (The Navy deals with this problem through its Bureau of Hygiene and Sanitation.)

The Commission on Training Camp Activities directs every effort toward preventing exposure to infection. The Surgeon General's office directs

every effort toward preventing the development of infection or the ravages of the diseases, and transmission to others by infected men.

There remains the civil profession's part, namely similarly to control the carriers in the communities. It is to this task that the Committee on State Activities is addressing itself in an effort to arouse the medical profession of America to its responsibility in combating this last of the great plagues which take their toll of human lives and happiness practically unchallenged.

The reading of a letter adopted this afternoon for sending to the State Committees best outlines the civilian program to be advocated.

To give effect to the application of the venereal disease program the following syllabus of administrative details should be promulgated:

- 1 The reporting of cases of syphilis and gonococcus infection to the health officers of jurisdiction should be immediate and under the following conditions:

a The physician may report each or any case by a key number instead of the name, provided he declares himself responsible for instructing the patient in the methods of preventing dissemination of the disease insuring proper living and working conditions, securing the examination of exposed members of the patient's family or associates, and for inducing the patient to accept continuous treatment and supervision until no longer a carrier provided further that he agrees to report promptly to the health officer the name and address of each patient who does not fully carry out the instructions given him.

b The physician may report each or any case by name and address upon beginning treatment provided the patient is told that such reporting will be a condition of the physician's attending the case. Under these conditions the health officer becomes responsible for instruction of the patient and protection of the community.

c The health officer must observe the same professional care in protecting the patient from publicity that is exercised by the private physician and will proceed with investigations of suspected foci of infection and the isolation of infectious persons with due regard for protecting the rights of individuals, it being understood that all records are confidential and not open to the public.

- 2 The reporting of sources of infection to the health officers of jurisdiction under the following conditions:

a The acknowledged prostitute must be reported by name and address.

b An infectious person who is not a prostitute may be reported by a key number, provided the physician can assure the health officer that such person is under treatment, and give the name of the attending physician if not himself treating such patient at the time.

c The patient who knows the source of his infection but desires to avoid giving the name and address to his physician may provide evidence that the carrier has actually come under treatment by a physician or clinic.

- 3 The reporting of monthly summaries of cases under treatment, and epidemiological data required by the health officer:

a The physician must report monthly on forms supplied him by the health officer the number of cases of syphilis and gonococcus infections he has treated, together with such data as may be useful in combating these diseases through general administrative measures.

b The physician who fails to comply with rules and regulations for the combating of venereal diseases may be

debarred from the privileges of laboratory diagnosis, salvarsan, and other supplies in addition to any penalties provided by law.

4 The provision of free laboratory diagnosis aids in both syphilis and gonococcus infections, to state city or private expense.

5 The provision of advisory stations for both men and women, where information concerning syphilis and gonococcus infections may be obtained and clinical examinations may be made when necessary.

6 The provision of adequate dispensary facilities.

7 The provision of adequate hospital facilities for patients requiring hospital care for their own well or the protection of others.

Where the isolation of such carriers is found necessary the hospital treatment should be intensive and at public expense.

8 The provision of an adequate supply of free salvarsan or its equivalents and of other drugs required in the treatment of syphilis and gonococcus infection cases, available under conditions which may be specified by the health departments of physicians, dispensaries, and hospitals co-operating in shortening the infectious period of cases reported by name and address.

9 The provision of pamphlets, cards and instruction form letters for follow-up of indifferent patients and other devices for assisting the physician in complying with the requirements of the health department.

The enactment of any necessary laws, ordinances or regulations for promoting the reporting and proper treatment of syphilis and gonococcus infections, for protecting the physician from damage suits in complying with such regulations for eliminating the medical charlatan from this field of medicine for limiting the drugstore dispensing prescriptions for these diseases written by registered physicians for protecting the privacy of all reports and records.

The co-operation of all civil authorities in dealing with syphilis and gonococcus infections on the same basis as that for other communicable diseases. To this end the assistance of the medical profession is valuable in investi-

gating suspected foci of infection, examination of male and female prisoners charged with disorderly conduct or vagrancy, the checking of the migration of carriers from one community to another and above all the education of their patients and the public upon the causes and consequences of these diseases.

As a special war measure the agreement of all physicians to refuse to treat men or officers in uniform without reporting the fact to the proper military medical officer and to co-operate in every way in promoting the government program for lowering the non-effective rate from venereal diseases among the Army and Navy personnel of the United States.

As a further special measure for the period of the war the committee on state activities recommends the appointment of qualified specialists in the treatment of syphilis and gonococcus infections as advisory committees to the state and municipal health officers; the activities of such advisory committees to be correlated by the joint supervision of the State Defense Council Committees on Health and the State Committees of the Medical Section of the Council of National Defense.

In order to avoid any possible misunderstanding that may arise as to the attitude of health officers on the question of the toleration by indirect acquiescence in vice by health departments, which has sometimes followed such medical inspection and treatment, co-operation should be offered and given by health officers and physicians to state or municipal officials and citizens who are responsible for the repressive law enforcement measures against commercialized vice.

Almost twenty years ago our beloved and honored Surgeon General stood before the task of eradicating yellow fever yet he did not flinch nor avoid his responsibility today he stands before this great preventive medicine problem, and does not flinch nor avoid his responsibility. It is for you, the leaders of the medical profession of America, to follow his example.

## GENERAL SURGERY

By MAJOR CHARLES H. MAYO M.R.C. U.S.A.

IN this great war which is pre eminently scientific in every department as it has been fought in the air on earth and in and under the water medicine feels very proud of its achievements. Only through medicine has it been possible with the enormous numbers of men in the field to carry on the war for three years. Had it not been for medical efficiency the war would have been terminated long ago from the same causes which have terminated wars in the past through disease and infection. We would possibly have had brought upon us a very unsatisfactory peace which would be far worse than no peace at all. Through medical efficiency the war will be carried on to a final termination which will end the wars of the present age and democracy will be safe in the world.

When war was first declared, the medical men of our country responded to the cry for aid to the call of humanity. Probably two thousand of our profession have been at work in England, hundreds have helped in France, in Serbia, in Russia, and in Italy, and also I might say some few hundred in Germany. We have thus among us men who have gained the intelligence derived from more than three years of work, and this is a great aid to the Surgeon General.

We feel very proud that after war was declared the first contingent representing the United States to go abroad was a medical one headed by Major George W. Crile.

We are proud from a medical standpoint but not from a humanitarian standpoint that Germany recognizes us by dropping bombs on our hospitals. We are proud too that we are returning in excess of 80 per cent of the injured back to the front.

It is unfortunate that the medical profession has not quite the rank to accomplish the things that today we are able to accomplish, that our people are very much opposed to making changes in rank, and still hold to the rules established during the War of Independence. One remembers that Washington did not even become a general, that Grant did not become a general until after the war, and then it was an act of Congress that gave him the rank as a reward of merit. So also was Sherman made a general and Sheridan, and now two more have received the rank. It is extraordinary that this great country as rich as any two countries in the world should base rank and the honors for work done in this war on the old time standards.

We cannot go from this country, either as medical or army officers with a rank which befits us properly to associate with the men representing France and England who are doing the same work. It is to be

hoped that this subject will be properly adjusted when the new Army of the United States is formed.

A few years ago the Medical Service in the Navy was largely a contract service. This has been changed and in the first six weeks after war was declared the entire Medical Service of the Navy was killed and the officers rank with those of any other country in the world. The Army should receive similar recognition not alone the Medical Department but the entire Army.

It is fortunate for our country for our soldiers, and especially for the medical men that we have in charge such a great man as Surgeon General Gorgas who is held in the highest possible esteem by the medical men of our country. Congress has honored him by bestowing upon him the rank of Major General, a rank higher than that given to the Chief of the Medical Service of our Army.

As has been stated before the war Surgeon General Gorgas' office consisted of only a few rooms. Now in one building there are more than one hundred and fifty doctors in uniform, there are five hundred and fifty clerks, and there is an overflow into two more buildings.

So you can realize the fact, some of you who have been delayed receiving your commissions, that there has been carried on a tremendous amount of work in the Surgeon General's Department in the handling of sixteen thousand medical men. In order properly to place the applicants, it was necessary to find out much concerning them as to their qualifications and standing, and to plan for their military and special medical instruction when the time came to take care of one million eight hundred thousand men in the camps for the same conditions would have to be anticipated in the camps as in any community of 30,000 to 75,000 people. The Surgeon General, with the aid of the various advisory departments in his office, has been able to put on the staffs of these hospitals of five hundred to twelve hundred beds eminent surgeons and professional men of the various specialties, many of whom have been secured from our medical colleges, universities and large hospitals.

The Surgeon General, with the aid of his department officers, has developed the greatest post graduate school of medicine in the world.

Unfortunately many of our best medical men, of our best surgeons fail to realize the necessity of any military training, yet most will admit the lack of the medical man's training in business and admit the necessity for accurate and uniform reports.

No measures are sanctioned in the Surgeon General's office except those which have stood the test of practice, and have been approved in the medical reports of the three years of warfare.

Some curious and false statements have been made as to the specialists. The specialists are doing a great work in the Surgeon General's office, but they are going to do exactly the same work there that they have done in civil practice in the history of medicine in our country.

Modern medicine is now too great a study to be compassed by one man, except in communities too small to support specialists. The Surgeon General has at his command, prominent representatives of the various specialties at the head of departments and sub-departments. Many of the specialists in the Surgeon General's office have done much in advancing American medicine to the high plane it now occupies.

The records which have come back to us show that in Over the T. p. fighting about 50 per cent receive head injuries of some sort that in trench warfare, possibly 30 per cent receive such injuries. There are about 50 per cent of chest injuries about 60 per cent of abdominal injuries, and 25 per cent of

the total cases on the average are fractures. A very large amount of the work is, therefore, classed as general surgery.

The Surgical Unit then consists of a man, the surgeon, up at the front giving his first aid, doing the best he can with few conveniences, the field hospital farther back the clearing stations and, finally the base and special hospitals.

The work of the General Medical Board of the Council of National Defense in charge of Major Franklin Martin, is of the greatest value to the Surgeon General's department. Through this Board is developed medical investigation and committee detail work, which upon completion is turned over to the Surgeon General for action. Major Frank Simpson is a member of a sub-committee of that most important committee of purchases and supplies. This committee co-ordinates the needs of the Department and through it is secured information concerning supplies their cost, availability and manufacture.

## HEAD SURGERY

By Major WALTER B. PARKER, M. R. C. U. S. A.

From the Division of Surgery of the Head, Office of the Surgeon General, U. S. A.

COLONEL Lyster, who was to speak to you tonight has been detained in Washington on duties incident to the war. In his absence the Surgeon General has directed me to represent him in the program and to speak of the activities of the division of Surgery of the Head. Before taking up the discussion of the subject assigned me I wish to express to the President and members of the Clinical Congress of Surgeons Colonel Lyster's appreciation of your invitation to appear on the program, and his sincere regret that he cannot be present and speak to you on the subject in which he is so keenly interested. He also requests me to voice his appreciation for the advice given and the assistance rendered him by the Sub-Committee on Ophthalmology of the Council of National Defense.

The sudden expansion of the Medical Corps of the Army, by the incorporation of civilian physicians and surgeons necessitated the consideration of new problems. One of the first problems to be considered was to determine how to give the Army the benefit of the services of those trained in a special branch of surgery and, at the same time construct the necessary organization to make them effective from a military standpoint.

At the beginning of the war it became the policy of the Surgeon General to utilize as far as possible the services of the surgeons in the line of their specialty. One of the steps in carrying out this policy was the grouping of those specially qualified, into a unit to be known as Division of Surgery of the Head. The specialties which form this group are ophthalmology, oto-laryngology, brain surgery

and oral plastic surgery of the face. As soon as this policy became known the specialists of the country dropped their reluctance to enter the service and willingly accepted commissions in the Medical Reserve Corps.

In the office of the Surgeon General this Division as a whole is under the direction of Lieutenant Colonel Lyster of the Regular Corps and to each sub-section is assigned a member of the Medical Reserve Corps.

The first duty of the division of the Surgery of the Head was to secure for the Surgeon General the names of a sufficient number of physicians qualified to do the work, who were willing to serve. In some instances, notably in brain surgery and oral plastic surgery there were not enough trained men available to meet the demand. To meet this emergency schools have been established where preliminary training is given. Details of this plan will be given later.

Through the activities of this division 580 officers of the Medical Reserve Corps are now on duty or ready for service. The number who have signified their willingness to serve is more than twice that number. Should the war necessitate the training of an army of three millions of men, it is estimated that the number of surgeons required by this section alone will be 3043.

The medical profession has responded so liberally to the call for service, that the Surgeon General may reasonably expect to be able to furnish that number when the time comes.

Another special duty of the division has been

to suggest plans and equipment and to advise on the personnel for a special Head Hospital with a capacity of 1000 beds authorized by the Surgeon General to be erected and operated somewhere in France at the proper time. In this hospital will begin the first work of reconstruction.

It is the purpose of the Surgeon General to establish schools of instruction for all the surgeons in the Cantonment Hospitals. To assist in this work teachers of known reputation have been assigned to take charge of the various divisions and textbooks dealing with the military aspect of each department are being prepared.

The spirit shown by the men assigned to duty in a National Army and National Guard Cantonment hospital who have had to contend with the discomforts incident to the development of a camp has been all that could be desired. In no single instance has there been the slightest indication that they did not realize the emergency and make the best of the situation.

In a few instances requests for a higher rank have

come to the heads of the various divisions. It can be said however that only in rare instances has service been refused because of the commission offered. It is not the province of this division to issue commissions. The Surgeon General authorizes me to say that it is the policy of his office to give the higher rank to those of large experience who on entering the service are qualified to assume full control of the special surgical service to which they have been assigned. To those in the lower grades it can be assured merit will be recognized and promotion given whenever it is fitting to do so.

If it is proper at this time I shall as a Reserve Officer take advantage of this opportunity to acquaint the members of the medical profession with the consideration shown by the Surgeon General and his officers of the Medical Corps. Our inexperience in military affairs frequently leads to inconvenience if not confusion. All the officers have been untiring in their efforts to set us right, and to assist us in the performance of our various duties.

## BRAIN SURGERY

By CAPTAIN CHARLES BAGLEY JR. M.R.C. U.S.A.

Chairman, Sub-Section of Brain Surgery, Division of Surgery of the Head, Office of the Surgeon General, U.S.A.

THE difficulty experienced by the average citizen in estimating the gravity of the present war is proportioned to the magnitude of the struggle. Many citizens seemingly entirely satisfied to leave the whole problem to others have however quickly responded when requested to perform a personal duty in the giving of advice, money or even life. In the same way the physicians in common with others failed to appreciate the full force of duty until their great work was divided into small parts. The announcement by the Surgeon General of the Army that the medical department was to be divided into various special sections demonstrated clearly the responsibility of the individual doctor. In focusing carefully upon the special section of brain surgery one is able to outline the responsibilities of a small group of surgeons and find the way for them to do their full part.

The wounds of war surgery of the nervous system may be classified as follows:

1. Tangential wounds in which the missile, usually a rifle bullet, has passed superficially to the bone leaving its mark externally in the form of a gutter with or without fracture or intracranial complication.

2. Penetrating wounds in which the missile has passed immediately beneath the bone. In these cases the laceration of the dura and brain is naturally inevitable. Bone fragments may penetrate more or less deeply.

3. Direct localized blows by fragments of shell or shrapnel bullets which have themselves failed

to penetrate the skull, but nevertheless have driven fragments of bone deep into the brain.

4. Penetrating wounds in which a missile has entered and remained lodged in the brain substances.

5. Cases in which a rifle bullet has passed across the cranial cavity the wounds of entry and exit being on opposite sides of the head.

6. Concussion of the spinal cord in many instances not associated with external signs of injuries.

7. Compression of the spinal cord when a detached splicule of bone is driven into the spinal cord these injuries frequently differing only in degree from those produced directly by a projectile.

8. Direct localized injuries resulting from fragments of shell or shrapnel, in which there may be extensive local destruction and often a considerable amount of blood clot.

9. Wounds or injuries of the peripheral nerves, of varying degrees again divided into a small group in which the nerve injury is of primary importance, and a much larger group in which the injury of neighborhood structure is of far greater significance.

The problems in the care of this varied group of injuries may be summed up as follows:

1. To reduce to a minimum that large group of cases likely to end fatally within the first twenty-four hours this to be accomplished by combating shock, and through what early revisional operative work may be indicated.



2 By combating infection. We have been told that as civilization has generally been dragged backward by the present war, so surgery has been dragged from the pedestal of asepsis to the mire of antiseptic surgery. This is to neurological surgery a serious blow since the advances made in this branch during the past few years have had to do chiefly with cases falling in the aseptic group. In fact we have been so defenseless in the battle against sepsis in surgery of the central nervous system, that little attempt has been made to combat such common diseases as meningitis.

3 The removal of foreign bodies and the searching for needles in the haystack. We are told that many foreign bodies lie superficially but patients with missiles deep in the substance of the brain do reach the surgeon and must be intelligently handled. The X-ray is of tremendous assistance not only in the localization, but also in directing the removal of fragments. The giant magnet so valuable in the handling of most of the metallic foreign bodies has a limited value and is capable of great harm. The multiplicity of these foreign bodies is perplexing and has resulted in many being left behind after an apparently complete operation, to excite encephalitis, abscesses, fungi and sterile traumatic cysts.

4 Hernia cerebri. In a survey of the literature, numerous articles are found describing methods of treating hernia cerebri and we are again impressed with the backward trend of neurological surgery. Many soldiers have died or have been seriously crippled as a result of this lesion in spite of the fact that for several years prior to the war not a single complication of this sort occurred in the largest surgical neurological clinic in this country.

5 Bony defects of the skull, and crippled brains are not of immediate importance but are here mentioned since they indicate a small degree of the tremendous problem of reconstruction which will fall to the division of brain surgery after the war. In passing I imply mention epilepsy with an earnest plea that every possible effort be made to reduce its occurrence.

After thus grouping the work we are confronted with the fact that there are very few neurological surgeons. The lack of special surgeons cannot be accepted as final, any more than was the diminutive size of our standing army at the outbreak of the war. The very small corps of neurological surgeons must undergo the extraordinary expansion now so conspicuous in all branches of the service. In what way can this emergency expansion be accomplished in the short time at our disposal? Let us begin by grouping our facilities.

We are in possession of a special technique peculiar to surgery of the nervous system.

2 We have a small group of surgeons who possess this special technique. Some of this group have already entered the field in France, a number of others are still in America, many of them carrying on their usual duties of civil life.

3 There are numerous laboratories and clinics, all at the disposal of the Surgeon General of the Army.

4. The literature is filled with the surgical experiences of our Allies and this too is easy of access.

5 A great many surgeons who have had good training and possess excellent judgment, many of them already in the Medical Reserve Corps of the Army are capable and willing to undertake this special work if given an opportunity further to fit themselves.

The first step in the expansion of the corps necessarily consisted in combining the teachers as represented in group two and the students of group five by utilizing the teaching facilities of groups three and four. With this end in view a conference of the members of group two was held in Washington, July 27 followed by similar conferences at late dates. When the needs were placed before the members of this conference, it was evident that their services and all the facilities of several universities were at the disposal of the Surgeon General. A plan was outlined with the aim in view of securing about 250 carefully selected candidates for neurological surgery from the large number of surgeons of the United States. To this end a letter requesting the names of surgeons qualified to undertake the work, was addressed to 150 large hospitals and to members of consulting boards appointed in every part of the Union. As a result about 700 surgeons were nominated. A questionnaire addressed to these surgeons has resulted in about one-half of the required number signifying their willingness to accept service in the Medical Reserve Corps and to be classified in the division of brain surgery. The training of these surgeons has been undertaken in a school established at the University of Pennsylvania, under the direction of Dr. Charles H. Frazer with the assistance of such able men as Dr. Spiller, Dr. Dorrence, Dr. Ludlam, Dr. Weisenberg, Dr. de Schweinitz, and Dr. Miller. Plans are now complete for the establishment of a similar school in this city under the direction of Dr. Dean Lewis, and with the assistance of Dr. Bramey, Dr. Carlson, Dr. Halstead and Dr. Herneck. A school will later be established in St. Louis under the direction of Dr. Ernest Sachs, and another in New York under the direction of Dr. Charles A. Ehberg. The course is so arranged as to deal particularly with the fundamental subjects such as anatomy, physiology and symptomatology of the nervous system. The necessary military training is being given in the various permanent hospitals and training camps.

After receiving intensive fundamental training, these surgeons will be capable of special clinical training in Europe. Again, we wish to make use of the available time and of the service of the leaders of neurological surgery already in France by establishing a school in the war zone. The definite details of this school it is hoped, will soon

be completed by an officer of the section of Surgery of the Head, now on his way to France. After the completion of the training the surgeons will be assigned to the various hospitals according to the exigencies of the service.

With a view of placing before the surgeons enlisted in the division of brain surgery the essential neurological knowledge contained in numerous textbooks and current medical literature the Surgeon General authorized the publication of a book. With the co-operation of the library of the Surgeon General and the various authors and publishers mentioned in detail in the preface Major M. G. Seelig has completed *War Surgery of the Nervous System*, a compact volume of 360 pages. The book has stimulated active interest in neurological surgery since the complex subject matter has in this way been condensed.

Because of the large percentage of infected wounds and the lack of knowledge of combating infection of the brain and spinal cord and their coverings animal experimentation has been undertaken with the hope of determining

1. The best methods of draining of the sub-arachnoid space.

2. The effect of mechanical washing of the space and

3. The reaction of the nervous tissues to the various chemical reagents.

Under the direction of Lieutenant Lewis H. Weed this work has been carried on for two months. At this date he can only report progress and promise a more detailed report in a few weeks.

The problem of neurological surgery, though only a small part of the combined work of the medical department is too great to be accomplished without the full help of the medical profession. For over three months we have been steadily compiling a list of candidates and are still in need of surgeons.

The work must be undertaken in an unselfish and self-sacrificing manner but, if properly done, the compensation upon completion may be summed up as follows:

1. To the individual soldier the best service

2. To the medical department of the army a small part of the great task, well done

3. To scientific research the advance that will necessarily come if all specimens are carefully preserved and correlated for postbellum study

4. To the civilian population all the advantages incident to the wider dissemination of a broader surgical knowledge.

5. To the individual surgeon, active in the work, the satisfaction of having done his part.

## OPHTHALMIC SURGERY

By MAJOR JAMES BORDLEY, JR., M.R.C. U.S.A.

Chairman, Sub-Committee of Ophthalmology General Medical Board, Council of National Defense

**D**R. FRANKLIN MARTIN has requested me to outline for the Clinical Congress of Surgeons the work of the Sub-Committee on Ophthalmology of the Council of National Defense.

This committee was authorized on April 26 and on May 13 made its first report to the General Medical Board. Since then without the intermission of a single day it has been in Washington working in an advisory capacity on the many ophthalmological problems of the Army.

The committee's activities have been so varied that only the most important can be considered tonight.

A complete catalogue of the nearly 6000 ophthalmologists in this country embodying the age, training and experience of every man, has been prepared. After eliminating those who as teachers, individual workers in dependent communities and men of small means and large family responsibilities, we have been able to hand to the Surgeon General the names of over 1400 men who have signified their willingness and are qualified to serve. Of this number more than 300 have been commissioned and more than 200 ordered to active duty.

We have studied the Surgeon General's plans for the organization of the army hospitals and where requested have made suggestions as to their per-

sonnel and the equipment necessary for eye work in the various establishments. We are delighted to say that many of our suggestions have met the Surgeon General's hearty approval and we feel that when the American Army is in the field the Surgeon General's plans for ophthalmic service will be found adequate.

At the request of the Editorial Committee of the Council of National Defense, a small book has been written, the title of which will be *Ophthalmic Military Surgery with Chapters on Trachoma and Malinger's*. The visual requirements for the various services of the Army have been submitted to us for study and suggestions. The glass which has been recommended for protecting goggles for aviators, ambulance drivers and soldiers has been submitted to us for investigation. In response to a request we have suggested a glass which possesses a selective absorption of light waves for use in binoculars, field glasses and range finders.

We have caused to be manufactured for the first time in the U. S. the soda glass necessary in the manufacture of glass eyes which heretofore has been manufactured exclusively in Germany. A member of this committee acting independently has devised a plan for protecting eyes against injury which we believe will be of far reaching value.

Discovering early the need for co-ordination in the work of all surgeons dealing with injuries to the head we suggested the formation of a sub-committee on Oto-Laryngology. After their organization we joined forces and at the suggestion of this joint committee the General Medical Board added to the personnel a brain surgeon and an oral face plastic surgeon. This enlarged committee is known as the Committee on Surgery of the Head.

In the Surgeon General's office there is a Division of Surgery of the Head about which Major Parker has spoken. In order to co-ordinate the organization work of the Army Division and the advisory work of the Council Committee the Surgeon General has placed in his office, Division Surgery of the Head several members of the Council Committee and Lieut. Col. T. C. Lyster, chief of the Division of Surgery of the Head in the Surgeon General's office has been appointed member of the Council Committee.

It is the Surgeon General's desire that we shall continue our work and with this end in view he called a member of the Committee into active service and assigned him to the division of physical reconstruction and re-education to assist Major King, the chief of the division in preparing plans for the re-education of blind and deaf soldiers.

Major King who is charged with this vast problem is tireless in his efforts to arrange a comprehensive plan and he seeks the best advice obtainable. With this very proper perspective he called together a group of twelve of the leading educators of the blind in this country to have them study with him this complex question. These educators not only know the problems which confront the blind in this country but they are likewise thoroughly

familiar with the work of the English and French in this war. On their suggestions Major King has arranged for the field service in France and for the establishment of a teaching institution in this country. A very patriotic and generous lady has placed at the disposal of the Surgeon General her very beautiful country estate to be used for the latter purpose.

Everyone who has given thought to the subject of re-education of the injured soldier knows that it is essential for the Army to hold him in the military service until his re-education is completed. In order to do this the Surgeon General must have supervision over every stage of the process. Indeed it is essential that the organization which will have the responsibility of the placing of an injured soldier in a trade or profession should likewise be directly under the Surgeon General who is charged with the duty of preparing that man physically for the battle of life.

This is in brief the general scheme and into it fits the blind soldier who must first, if possible, be reconstructed ocularily and if not, then re-educated and placed in such a position that his future happiness will, as far as possible, be assured.

I cannot close without expressing the high regard of the Sub-Committee of Ophthalmology for Surgeon General Gorgas who has always welcomed our suggestion, who has always found pleasant tasks for us to perform and who ceaselessly works for the upbuilding of his very important Department. Nor would I close without saying that the individual members of this Committee will forever thank Dr. Franklin Martin and the General Medical Board for the wonderful opportunity he has offered us to serve the Army and the Nation.

## ON SURGERY OF THE EAR NOSE AND THROAT

By C. W. RICHARDSON, M.D.

Chairman, Oto-Laryngological Sub-Committee, General Medical Board, Council of National Defense

ON March 19, 1919, the Presidents of the American Otological Society, the American Laryngological Association and the American Laryngological, Rhinological and Otological Society were requested by the General Medical Board of the Council of National Defense to appoint a committee to advise the Council to what degree and in what activities these specialties could be made available in the event of war being declared. The three societies above mentioned appointed Dr. Burt R. Shurly of Detroit, Dr. Harris P. Mosher of Boston, and Dr. Charles W. Richardson of Washington as members of this committee. Each member of the committee is an active member in all three of the above mentioned societies. This committee met in Washington on March 23 and 25, 1919, and after due consideration formulated answers to queries suggested, and forwarded them

to Dr. F. F. Simpson, Chief of the Medical Section, Council of National Defense. It was not until June 2 that the committee was called before the General Medical Board to present a formal request for its incorporation as a sub-committee on the nose, throat, and ear of the surgical specialties.

The Executive Committee at its meeting Monday June 3 authorized the committee to commence its activities. With the formation of the Sub-Committee on Oto-Laryngology its membership was made up of Lieut. Col. Theodore C. Lyster, Surgeon G. E. Triple, U. S. N. and the three members of the original committee. Dr. Charles W. Richardson was elected chairman.

The first activity engaged in by the committee was the listing of all the known specialists in this branch of medicine throughout the United States and preparing an index catalog. Through this

means we have discovered that 852 men were available for service. Of this number 43 oto-laryngologists have been assigned to National Army Cantonments, 34 oto-laryngologists have been assigned to National Guard Cantonments. The number of oto-laryngologists listed as eligible that is who have accepted their commissions and are awaiting assignment to duty is 140. The number of oto-laryngologists who have not accepted their commissions but to whom commissions have been granted is 44. The number of oto-laryngologists who have been assigned to go abroad is 32. The number of oto-laryngologists who have signified their willingness to accept service but have not yet taken out their application papers is 852. The number of oto-laryngologists estimated as needed for purposes of expansion is 750. Many of these men are now in the Medical Officers Reserve Corps and before long all will have accepted commissions.

Our method of cataloging and card indexing has followed the system inaugurated by the Sub-Committee on Ophthalmology to whose chairman, Major Bordley we are indebted for many suggestions.

On July 15 in conjunction with the Sub-Committee on Ophthalmology we were able to place one of our members Major H. P. Mosher in the Surgeon General's Office under Lieut. Col. Theodore C. Lyster, chief of the section of Surgery of the Head. Through this opportunity we were enabled to get in closer relations with the Department and thus do much more efficient work. Early in July the General Medical Board granted permission for the Ophthalmological and the Oto-Laryngological Sub-Committees to meet in joint session. One of the first results of these meetings was the creation of the Surgical Head Unit. This unit consists of ophthalmology oto-laryngology brain surgery and oral and plastic surgery. The brain surgical element has become a constituent of the Ophthalmological Sub-Committee and the oral and plastic element has become a constituent of the Oto-Laryngological Sub-Committee. Weekly meetings of the surgery of the head committee are held. Four representatives of the committee have permanent positions in the Section of Surgery of the Head under Lieutenant Colonel Lyster in the Surgeon General's Office. Other activities of this committee have been the standardization of oto-laryngological instruments to aid the Surgeon General to assign the proper personnel to cantonments and base hospitals, the revision of hearing requirements for entrance to the Army, the assembling of tests for malingerers and the near perfection of an ear protector. The committee on Oto-laryngology has planned a special hospital and dispensary building for the Section of Surgery of the Head for the National Army Cantonment and for the base hospitals abroad. All of these activities have received the approval of the Surgeon General. At present a manual of war surgery of oto-laryngology is being prepared by Major Hannu W. Loeb of St. Louis at the request of the committee. During

the month of August several trips were made by members of this committee to various cities, in order to explain to oto-laryngologists the activities of this committee and awaken interest in the members of this branch of medicine to their opportunities for service. Reports have also been sent out by this committee through the secretaries of the national oto-laryngologic societies to all of their membership outlining the activities of this committee. Through the presence of Major H. P. Mosher in the Surgeon General's Office we have been enabled to suggest to the chief of the personnel bureau the appropriate grade to be assigned to various officers receiving commissions. In this work we have been ably assisted by our advisory committee members of which are our best known oto-laryngologists in each of the states of the Union. The names of candidates unknown to the committee as to their professional qualifications are referred to the advisor in the state from which the candidate comes and an accurate account of his qualifications is thus obtained. We have also been enabled to suggest the names of the men to be assigned to each of the cantonment special hospitals. It is almost needless to state that all the majors in charge of these hospitals are men famous in this special line of surgery and their assistance almost as well known in our specialty. We are now preparing a roster of the men to be placed in the base hospitals abroad. Through the assistance of one of the members of this committee a legislative act was so shaped as to assure the reconstruction of the soldier and sailor to these arms of the service. The reconstruction re-education and rehabilitation of the defective in hearing and speech among the soldiers is receiving due consideration by this committee. On September 29 a meeting of physicians interested in and educators of the deaf was held in Washington and as a result of this meeting a preliminary report was made by Major Bordley, who represents the Section of Surgery of the Head in the reconstruction bureau under Major King. A second report has just been prepared indicating the various steps by which the objects sought may be attained. In the last week there has been a change in the Committee. Dr. Burt R. Shurly having resigned in order to accompany his unit abroad, and in his place the Council of the American Laryngological Association has nominated Dr. Joseph H. Bryan of Washington, D. C. to the Council of National Defense as a member of this committee. Dr. Harris P. Mosher having been ordered abroad, his place is now occupied by Dr. C. W. Richardson in the Section of Surgery of the Head.

I wish to express the appreciation of this committee for the unflinching courtesy and kindness of our Surgeon General, and also of the various administrative heads in his department and further to express the appreciation of the committee for the courteous kind co-operation and advice of the chairman of the General Medical Board of the Council of National Defense Dr. Franklin H. Martin.

## THE AIMS OF THE SUB-SECTION OF PLASTIC AND ORAL SURGERY

BY MAJOR VILRAY P. BLAIR, M.R.C., U.S.A.

In charge of the Sub-Section of Plastic and Oral Surgery, Section of Surgery of the Staff, Office of the Surgeon General, U.S.A.

OF not uncommon occurrence in the present war are those distressing wounds of the face and jaw bones which have attracted particular attention, not only on account of the disfigurement which they cause, but even more so from the difficulty that was at first encountered in dealing with them. This difficulty is the logical outcome of an attitude that regarded dentistry and surgery as two distinct and separate professions. As long as this theory was allowed to dominate practice, a man who had an extensive injury of the face and jaw bones had about as much chance for an ideal result as had the man with an open fracture of a limb—the days when the physician and the bone setter could find no common ground upon which to meet. The bone setter and the physician who refused to recognize the surgeon, are of the past; but the surgeon and the dentist in their relation to each other only too frequently perpetuate the agnosticism of those older practitioners.

It is now accepted as axiomatic that in dealing with an open fracture of the thigh the fixation of the bones and the treatment of exposed tissues should be concurrent and that early treatment is one of the most important factors. It is not universally recognized that these same principles hold in the treatment of a wound involving the jaw bones and the soft tissues; whether it be the result of an industrial accident, a removal of a tumor, or a war injury.

The surgeon has expended much study upon making himself master of the various means of splinting an injured limb, but proper fixation of a fractured jaw can only be done by the use of dental splints. These he cannot apply himself, and he has not always sought the help that the dentist could so easily lend.

The late von Langenbeck after the War of 1870 said: "I would not care to go through another campaign without the help of skilled technicians to aid in the care of these jaw injuries."

The surgeon is not technically trained to splint these cases, yet early proper fixation is one of the most important points of the treatment. The dentist as such is not trained to care for the wounded tissues beyond fixation of the bones, yet repair of the soft tissues and proper drainage may be equally important. A few have bridged this no man's land between surgery and dentistry; recently a much larger number have learned co-operation, but today I believe that the majority are pursuing their separate ways; that a patient with a jaw injury will be treated either by a surgeon or a dentist, neither of whom is master of all of the problems and that either the fixation or the care of the tissues will suffer accordingly.

I crave pardon for injecting a personal note to the extent of begging that nothing be interpreted as the slightest criticism of the men who have been doing this work in the present war. We have a grave problem, and we must analyze the circumstances with which we have to deal. Anyone who is familiar with the results that have been obtained by Kazanjian, Hayes, Davenport, Morestin, Valadier, and the other men who have been doing this work abroad can have but one opinion of what has been accomplished, but these men have now been engaged in this work for one or more years while we have not yet started.

It is or has been the custom to transport these cases back to special centers where qualified men are stationed. In the meantime the patients receive what might be called a better term be called general treatment. We have recently been told by Crile that the most important step in the preparation for the care of our wounded is to plan to give them the proper operative treatment within the first twelve hours and if this is done, that primary union may be obtained in 90 per cent, and that gas gangrene etc. may by this means be eliminated. This may be too much to expect literally of mouth injuries, but I feel absolutely certain that in over 90 per cent of these cases earlier treatment would accomplish even better results than late treatment where reconstruction must overshadow conservation, and that Kazanjian, Morestin, and the others could accomplish even better results in the individual cases with less effort and less distress to the patient. If they could have their plan of treatment started in the earlier hours after the injury, than later when the wound is complicated by infection, muscular spasm, infiltration of the tissue or scar contraction.

In the light of our past clinical observation and of what we have learned from workers abroad, it is our hope to place in every evacuation, base, and recovery hospital, men who are familiar with the problems and technique of dealing with these face and jaw injuries so that from the very first each of these patients will receive the best that surgery has to offer.

Where are we to get the large number of trained men to do this work on the scale as planned?

There are in this country at present a large number of men who have specialized in oral surgery. These are men of dental training, many of them with medical degrees who have gone beyond the treatment of the teeth, to devote their attention to the periodontal structures. These men understand most of the oral problems, the application of splints, etc., but as a rule are not accustomed to doing the major surgery that is required for many war injuries.

The surgical principles of treating oral and face injuries are the same as those applicable to wounds of any part of the body.

Wounds of the soft parts, if seen early before infection has occurred, may frequently be immediately repaired by suture. The wound is cleaned of all blood clots hemorrhage is controlled and foreign bodies are removed with the latter are included totally detached bone fragments. Above the lower border of the body of the mandible local and general conditions permitting immediate closure of the wound should be made, but all shreddy and pulplified tissue is removed by clean excision, no attached fragments of bone being removed. If the defect is too large for simple suture, then, local and general conditions permitting undermining of the borders may be done with provision for drainage of these pockets or the wound is closed by flap operation. If the parotid duct is severed, provision for drainage into the mouth is made. In the neck there are two especially notable danger zones in reference to subsequent infection (1) The lower parts of the subfacial spaces that lead directly in to the mediastina and (2) the immediate wound area about a ligated carotid or carotid primary branches. In the first instance the danger is that of mediastinitis whereas in the second it is the possibility of fatal secondary hemorrhage. The blood supply and therefore the resistance to sepsis, is not as good in the neck as on the face. Recent wounds after proper preparation are sutured with ample provision for drainage. If the deep subfacial spaces are opened, in the deepest part of the lower end of each invaded space a small strip of gauze packing is placed. If one of the primary branches of the external carotid artery is divided, this part of the wound is packed, because sepsis here predisposes to fatal secondary hemorrhage. A wound in the trachea or larynx may be sutured, the more superficial part being packed to furnish drainage away from the tracheal lumen. A wound of the pharynx or oesophagus is sutured and the line of union reinforced by some super-

imposed tissue, but the mediastinum is guarded by a light packing at the lowest and deepest part of the wound. These packs are not allowed to remain when fouled. A wound completely through the floor of the mouth as Billroth long ago pointed out should never be primarily sutured on account of the danger of indurating infection and secondary hemorrhage. If the bones are involved, then the remaining portions should be splinted in their proper positions and no attached fragment removed. Every pocket every open bone cavity and the lower end of every fracture line should have efficient dependent drainage. If this is done early it is surprising to note the conservation and regeneration that may result. After the bony fixation and drainage have been provided for then the soft parts may be repaired as outlined above. The necessity for late repairs will largely be in inverse ratio to the early care that the case has received.

It is by associating the capable general surgeon with the dental oral surgeon and sending them out as units that we propose to furnish this skill in multiple. If any apology were needed for this plan it is to be found in the recent report in a lay journal by W. W. Keen of the operation performed upon the late President Cleveland in which one maxilla was removed and replaced by a prosthesis so perfect as to defy detection. This was an example of co-operation of the surgeon and the dentist.

In order to correlate the work and to present the special war problems, short course schools have been established by the Surgeon General in several cities where these surgeons and the dental oral surgeons working together will be molded into working units.

Until their services are needed abroad, these units are co-operating with the dental surgeons at the cantonments in an attempt to eradicate periodontal infections from the mouths of our soldiers. It is hoped by this to materially lessen the medical casualties on the other side.

These are the aims of the Sub-Section of Plastic and Oral Surgery in the program of preparedness.

## ORTHOPEDIC SURGERY

By MAJOR E. G. BRACKETT M.R.C. U.S.A.

It is one of the far sighted policies of our Government to begin in the midst of its early preparations for the destructive part of war to make just as elaborate preparations for the repair of that human damage, which will come as a result. These preparations are being made not merely to repair those physical disabilities which will be a part of the casualties, but just as extensively for the complete restoration of the efficiency of the man, physical and industrial. This effort is based on the acknowledgment that a man, who is well and a wage earner

is taken from the community and is placed in the service of the Army and there injured. He should therefore, be considered as a ward of the Government until he can be returned to civil and industrial life restored in every respect to his highest level of efficiency.

The problem has been made clear to us by the allied countries which have been obliged to work out its solution under an emergency. We have the advantage of being able to learn from them the methods and the size of the task. With this oppor-



have applied for work in this division. This course is given in the form of intensive training in the universities and hospitals. This training is intended to give the necessary preliminary instruction in the principles which will be applicable to the military needs of orthopedic surgery. The training will be continued under the older orthopedic surgeons who are in service and on duty at the various posts. Men are chosen for this training who have already had surgical experience and practice. This special training should result in eventually producing the best type of surgical specialist *vis* the surgeon who has turned his general surgical experience into special lines of work in order that he may focus his skill and through such concentration, produce the greater efficiency.

II *The establishing of industrial occupational facilities* in intimate relation both administratively and geographically with the hospital.

Thus the curative workshops will be built as part of the hospital equipment so that the men while still confined to the hospitals may at the same time be carrying on their vocational and curative work. In such an arrangement, where the vocational work overlaps the surgical no time is lost.

The necessity of getting injured men well enough to return to their normal occupations at the earliest possible period is so well recognized by medical men and by those who have to do with industry that it needs only to be mentioned. When once the grip on the working habit is lost, particularly through the depressing influences of protracted physical suffering the recovery of the atrophied mental grip is rare. Under the conditions of war this menace will present itself in its worst form.

This work of the orthopedic rehabilitation must be looked upon as having three distinct phases yet so closely allied and interwoven that they make one problem.

1 The physical restoration.

2 The industrial re-education to fit the new physical conditions into the existing social relations, which must be resumed.

3 The re-installation in normal employment.

The man must first be reconstructed surgically so that he may be rehabilitated industrially under

the most favorable physical conditions. The industrial re-habilitation is difficult enough to the pupil and involves many pitfalls and discouragements. We must remove all avoidable obstacles that the task of re-learning may be as smooth as possible. This means the preparation for early care. It means the anticipation of those disabling conditions which as a result of injuries threaten the locomotive system, and the installation of preparation for them. It means the early installation of simple occupations adapted to the period of convalescence to avoid even the early subconscious habit of idleness, which students of such cases tell us may begin in two weeks. It means linking to the surgical treatment the industrial work in order that it may be a curative element in the period of recovery. It means the placing of the individual in his reclaimed condition into that position where he can best use his powers.

This work of rehabilitation in its three phases of restoration, re-education, and re-installation, is an activity which is most stimulating for it is not directed alone toward the provision of a temporary emergency which will end with this military crisis.

The need of this same rehabilitative work as a factor in solving our civil and industrial problem, has been evident for some time and already attempts have been made to meet the need through the establishment of such work. Thus this military problem will merge directly into the permanent civil one, and can then be turned over to meet the municipal demands. The establishment of this rehabilitative work under the military necessity its development under a Federal control, with the working out of the practical details of operation, its demonstration as a working plan, with the various means by which it may be accomplished the education of the people as a whole to its recognition and its necessity can be brought about under this appealing crisis in a way and to a degree of completion, and at a rate that would be impossible under any other conditions. It will make it one of the lasting contributions which can come out of the disasters of this war.

Therefore, with your help if we build wisely we shall build permanently.





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